Community-based research: science conducted as if people really matter

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ABSTRACT

The presentations given in this symposium have sought to examine the apparent clash between two worldviews or paradigms. In this paper, I begin by defining community-based research and examine the nature of two paradigms of science that seem to lay beneath the surface of any discussion of community-based research. I then consider what roles the professional scientist and members of the wider community have in research activity under these paradigms. This is followed by an exposition of the key features of successful community-based conservation work, including community-based research activities. Some scientists argue that community-based research does not work, that it is not worthwhile and that science should be left to the scientific elite. They cite poor data quality, particularly that part due to observer bias, and a general lack of rigour in the work. I argue here that there are some counter examples that show that community-based research can work and seek to identify those key factors that appear to be necessary for success. Some of these are technical and some relate to people management. Community-based research is not a "must do" for the professional scientist and it is not a panacea for conservation ailments. It is another useful tool for gathering data and used wisely can yield scientific, social and political rewards not possible by any other means.

Community-based conservation and research

The push towards greater involvement of members of the community in the development and implementation of conservation and natural resource policy gathered momentum throughout the 1970s and 1980s. Much of this arose from the United States National Environmental Policy Act and the National Forest Management Act which set a legislative mandate and a framework for collaboration and partnerships between scientists and decision-makers, and eventually the wider community (Garcia 1989; Cortner and Moote 1994; Morrison and Marcot 1995; Carr *et al.* 1998). A great emphasis has been placed on this approach in many parts of the world (Sutherland 1998; Wilson 1995). Throughout the world, this shift in philosophical position has lead to a plethora of polices, programs and strategies that place a strong emphasis on community participation (e.g., The United Nations Convention on Biodiversity or Agenda 21), and at many levels of government. In Australia, for example, we have polices or strategies operating at the national level (e.g .,The National Strategy for the Conservation of Australia's Biological Diversity), the state level (e.g., New South Wales Biodiversity Strategy), and the local government level (e.g., local government state of the environment reports required by legislation in New South Wales). It has also led to significant changes in the way in which resource management agencies operate (Garcia 1989; Morrison and Marcot 1995; Papps and Wilson 1995).

As part of that broader development, efforts have been made in many places to engage interested or affected community members in data gathering and analysis, as well as the process of interpreting results and determining acceptable outcomes (see Saunders 1990; Dvornich *et al.* 1995; Martin 1995; Saunders *et al.* 1995; Alexandra *et al.* 1996). Scientific knowledge is but one of a number of streams of influence in conservation

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decision-making. We must remember that non-scientific value judgements, common in the realms of economic, political or bureaucratic life, and not erudite scientific argument, will in the end decide whether, say, old-growth forests survive (Franklin 1995; Lawton 1997).

Nevertheless, the value of science in conservation decision-making is great because it constrains the debate to a more reasonable set of issues. Scientific knowledge, in effect, grounds the debate and can cut through the clutter and noise to reveal the essential truths that must be accommodated (or perversely disregarded!) in any decision regarding conservation and the management of natural resources (Franklin 1995; Ehrlich and Ehrlich 1996; Lawton 1997). The likely value of increased public participation in scientific research is a far greater understanding of the scientific process and the nature of the scientific information being fed into the decision-making process.

Members of the wider community can participate in data gathering in a number of ways ranging from unaided, casual observations of species occurrences, through volunteers on a field trip, to genuine partnerships where costs, benefits and responsibilities are shared between professional and non-professional interests (Trauger *et al.* 1995). However, not all forms of community participation in data gathering are equal in scientific and socio-political value (Figure 1). I restrict my use of the term "community-based research" to partnerships between scientific experts and other interested parties aimed at performing studies that have high scientific value and maximum social and political impact. Partnerships are widely thought to provide the best opportunities for community-based research to yield high quality science and maximum value to participants and maximum impact on decision-makers.

Thus, community-based research, sometimes referred to as "community monitoring", is perhaps the most powerful tool for engendering a greater understanding of the scientific process and the limits of reliable and objective knowledge amongst an interested and influential group within the wider community. The term can obviously cover a wide range of situations. It may include casual monitoring of some environmental attribute with little rigour or statistical power but perhaps some educational value. It may also include well-

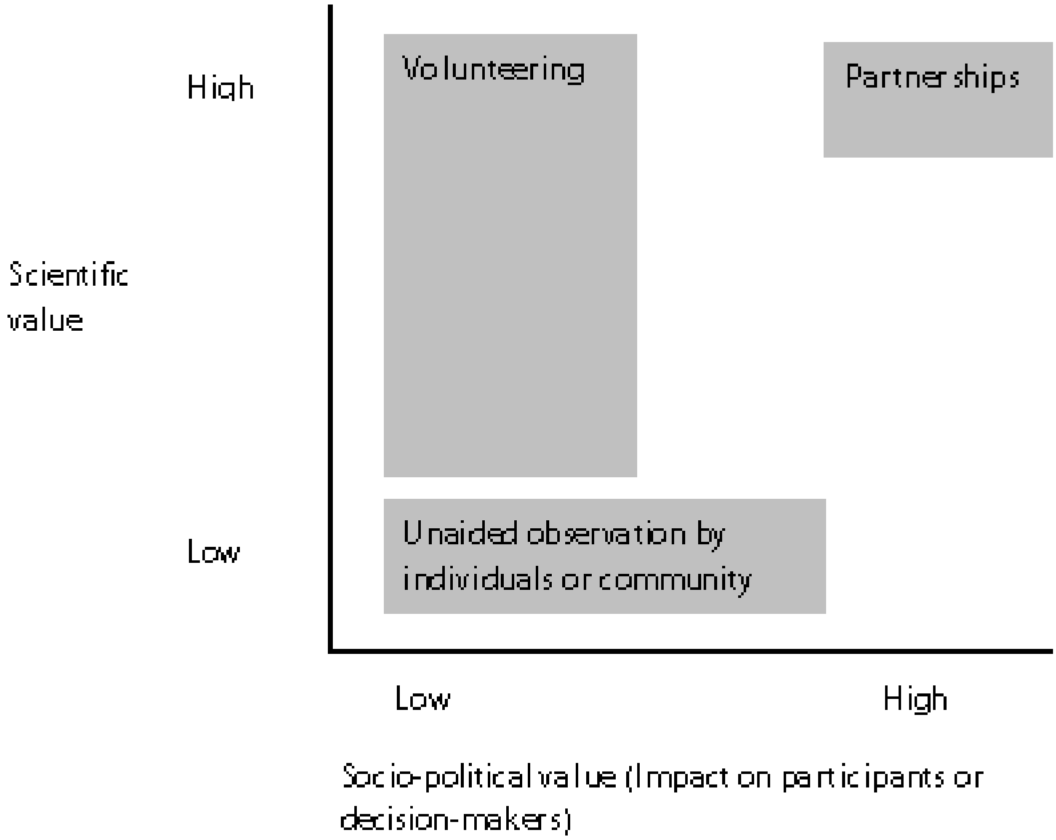

Figure 1. Members of the wider community can become involved in scientific studies in three ways: conducting unaided observations, working as a volunteer on a scientific project, or through partnerships with scientific experts. Each will vary in its scientific value or credibility and in socio-political impact.

conducted studies that teach the participants a great deal about the process of scientific research and yield data useful in rigorous statistical analyses that may have great impact on decision-making processes. This range in the nature of community-based research was amply demonstrated in Alexandra *et al.* (1996).

Two paradigms of science

There is a spectrum of opinion within the scientific community regarding how we should respond to the challenges presented by community-based research. The ends of the spectrum may be characterised as two different world-views or paradigms.

Elitist or privileged position paradigm

In this worldview, scientists are members of a higher caste with a unique and privileged perspective on the meaning of life (Bronowski 1951; Wren-Lewis 1974). They are in possession of a wealth of knowledge and, as so many pundits tell us these days, knowledge is power. Ordinary folk cannot possibly understand, let alone participate in, scientific research and wielding that power is for the select few. A flow-on from this world view is the belief that professional scientists can sail on doing good research oblivious to the needs of those around them and the changed context of their work. Carrier (1995) has termed this the "Nero Syndrome". Franklin (1995) refers to it as "scientific hubris".

Democratic paradigm

A more democratic view is espoused by many and is now considered the prevailing socio-political paradigm. In this view of things scientific, scientists are distinguished merely by the fact that they have been interested enough, and are sufficiently predisposed to a rational method of inquiry, to pursue a career in scientific research. As Albert Einstein expressed it "*the whole of science is nothing more than a refinement of everyday thinking*" (cited in Jones 1996). Somewhat earlier in 1894, T.H. Huxley gave a similar, and typically more colourful exposition, when he stated that "science is nothing more but trained and organised common sense, differing from the latter only as a veteran may differ from a raw recruit: and its methods differ from those of common sense only as far as the guardman's cut and thrust differ from the manner in which a savage wields his club" (cited in Jones 1996). Bronowski (1951) and Wren-Lewis (1974) also present a defence of the democratic paradigm.

I think that the elitist view of science is wrong for the following reasons. Scientists are ordinary people albeit in a rather unique and privileged role. What distinguishes them from other members of the wider community is the emphasis scientists place on the process of accumulating objective knowledge of the natural world and their ability to access, analyse and interpret a vast store of accumulated knowledge. Scientists also understand the limits of our knowledge.

I also believe that the elitist view is wrong on ethical grounds. Given that scientists have gained profound insight into the workings of the natural world, and that insight is considered by many to be essential to making informed choices about the future direction of our society, then for scientists there is a clear moral obligation or duty towards our fellow citizens to share those insights. A strong sense of that duty emerged early in the development of modern science with the leading scientists of the late eighteenth and nineteenth century engaging in many forms of public presentation (e.g., the annual Faraday Lectures of the Royal Society, and lectures conducted by T.H. Huxley and many others). I will not consider these ethical questions further for they have been well-covered by others (e.g., Wren-Lewis 1974; O'Neill 1993; Ehrlich and Ehrlich 1996; Resnik 1998).

I also believe that the elitist view is wrong for strategic reasons. Whether or not you agree with the direction and content of recently developed conservation strategies, all of them have as a foundation stone the formation of partnerships between scientists, decision-makers and members of the wider community. The expectation amongst conservation community groups and bureaucrats is that scientists will enter into genuine partnerships. It would seem strategically prudent to seek ways of making such partnerships productive for all those involved.

The role of specialist and expert

In the face of an increased push towards community-based research, many professional scientists express the fear that their role in society and the quality of science itself is under considerable threat. Some also argue that empowering the community to undertake a task such as monitoring the size of a population of endangered plants, will cause a breakdown in decision-making. Scientists holding this point of view doubt the veracity or quality of the data gathered by a group with little or no training and a vested interest in a favourable outcome, and worry about the potential for wrong interpretation of data by non-scientists.

I do not see that specialist knowledge and expertise is under threat from such activities as providing opportunities for wider community participation in serious scientific studies. With few exceptions, I have found that people interested in conservation place value on, and clearly benefit from, the contribution that can be made by scientific or other experts. There is strong evidence to show the net benefits to Landcare groups from the active involvement of government experts and support officers (Curtis *et al.* 1993), and that this is recognised by Landcare groups themselves. This is reinforced, for example, by Martin (1995) who worked with a Victorian Landcare group to monitor land degradation, and by the results of a comprehensive survey undertaken by Alexandra *et al.* (1996) which showed that partnerships are actively sought and very highly valued by those involved in community-based research. My own observations confirm that many capable community members are keen to participate in research teams lead or supported by experts. There are people in the general community who can do good science in partnership with professional scientists.

Keeping the science in community-based research

Any thoughtful consideration of the process of scientific research leads to the recognition of several critical areas that require special attention to ensure the highest standards can be attained in community-based research. They are study design and feasibility assessment, selection of data gathering and data handling methods that ensure the highest data quality, and people management.

I will not dwell on the first area, study design and feasibility assessment, except to note that the spatial and temporal variation within the study area will have major implications for the selection of survey sites and the duration of the study. There is a fundamental need to ensure sufficient replication within the survey design and that survey site selection provides an unbiased representation of the range of environmental variation. Further guidance on survey design is provided by Green (1979), Krebs (1989), Greenwood (1996), Underwood (1997) and New (1998) amongst others.

My emphasis here is on the interaction between the other two areas: survey methods and people management. It is my view that these two elements, acting in concert, are the critical determinants of scientific value in community research. These areas and their interaction do not appear to receive explicit consideration in reviews of community research (see Saunders *et al.* 1995). My argument is that maximising a parameter called "data quality" when selecting and implementing survey methods is the key to maximising scientific value in community research.

Most of the examples discussed below come from the literature on fauna survey methods, my area of expertise. I have also drawn heavily on the ornithological literature. This is inevitable because of the long history in that branch of the natural sciences in dealing with questions of data quality and data management in studies involving collaborations between professional and non-professional scientists. However, these biases in the source of examples do not detract from their value for the same issues face all forms of ecological study, particularly those that involve many players from diverse backgrounds, skill levels and experience.

Data quality

Data quality is high when observations are conducted in ways that maximise precision and accuracy, minimise bias and minimise data handling errors during transcription or recording.

Precision refers to the spread or scatter of successive measurements. Low precision means that the data spread is broad and in turn means that the ability to detect differences between samples, or trends through time, is reduced.

Accuracy refers to the degree to which the average of the observed values represents the actual or expected value of the thing being measured. Alternatively, it can be said that an accurate set of measurements truly reflects the phenomenon you are observing.

Bias is a constant trend in some direction that reduces accuracy. An underestimating method is said to be "negatively biased". An overestimating method of measurement is said to be "positively biased". Most observation methods relevant to measuring some component of biodiversity are negatively biased. It is usually the case that even the sharpest of observers or the best census method will miss a fraction of the things being observed. However, the magnitude and direction of bias of most observation or survey methods used to study species distribution and abundance are not easily estimated since we frequently do not know the true or expected value. Provided that the bias is reasonably consistent between samples, it is possible to use these biased estimates as an index of the true value (Krebs 1989; Bibby *et al.* 1992; Greenwood 1996). This should be done with some caution as we often do not have a sound understanding of the relationship between an easy-to-collect index and the biological parameter it is thought to represent (Thompson *et al.* 1998).

Following the outline given in Bibby *et al.* (1992) several sources of influence on data quality, particularly bias, can be identified. They include effects due to observers, survey method, habitat, species, season and time of day, and weather at the time observations are made. I will briefly examine each of these factors to see what the implications might be for maximising data quality, and therefore scientific value, in community-based research.

Observer effects

The fear of a rampant "observer effect" or observer bias is perhaps the most serious and often raised concern amongst scientists regarding community-based research. This term refers to the different results of field measurements, counts or observations taken by different observers (i.e. variations in degrees of accuracy, precision and bias) when they apply the same survey method. Apart from dishonest recording of data or selective reporting of observations to favour a particular outcome, variation in data quality between observers is simply a reflection of natural variability in aptitude, ability and motivation. To the novice, the term may have pejorative connotations but professional biologists are also prone to it. So important is the phenomenon of observer bias that much work has gone into analysing the factors influencing the level of observer bias for a given census method. There also has been extensive research into ways in which it may be minimised or accounted for both at the time of data collection and in subsequent analyses. However, making adjustments during data analysis to accommodate observer effects tends to weaken the strength of the conclusions that may be drawn from the analysis (James *et al.* 1996) and should be undertaken with caution.

Approaches recommended in the literature to manage or account for observer effects, particularly when attempting to use observers of widely disparate skill or experience levels, include:

(a) the exclusion of the first year's observations from novices (Kendall *et al.* 1996); (b) only analysing data between survey sites when there are no changes in observer for that year (Bibby *et al.* 1992); (c) including observers as covariates in analyses and other means for adjusting for observer differences (James *et al.* 1996; Thomas 1996; Link and Sauer 1998); (d) selecting census methods and target species that are less prone to observer effects (Greenwood 1996; NBS 1997; Freilich and LaRue 1998); (e) designing field or observational activities so that changes in observers are minimised, the allocation of observers to sites is fully randomised, and that a fixed or known pool of observers is used for a given technique (Jaeger and Inger 1994; Eason *et al.* 1996); (f) only using observers with proven ability to identify or detect the species being observed or implement survey methods (Cyr 1981; Kepler and Scott 1981; Ramsey and Scott 1981; Emlen 1984; Ralph *et al.* 1995; ICLARM 1997; Freilich and LaRue 1998); (g) the provision of training to enable observers to meet explicitly defined standards (Kepler and Scott 1981; Dvornich *et al.* 1995; Eason *et al.* 1996; ICLARM 1997); and (h) allowing for individual variation in the ability of observers to resist the distractions of fatigue, bad weather and illness (Tasker *et al.* 1984; Southwell 1996) or boredom (Scott and Ramsey 1981) when survey methods are being designed.

Survey method

Apart from the impact of observer effects, it is inevitable that there will be a component of bias that is due to the nature of the survey or observation method. This can include effects due to variation in the quality of equipment used (e.g., quality of binoculars used in bird observation, see Bibby *et al.* 1992; Catterall *et al.* 1996), changes in trap sizes or spacing, and so forth (Friend *et al.* 1989; Hobbs *et al.* 1994; Tew *et al.* 1994; Mesibov *et al.* 1995).

Survey effort

There is usually a direct relationship between the effort expended on observation and the amount of information gathered, leading to the well-known species accumulation curve (Krebs 1989). Greater effort ensures that the likelihood of detecting rare or cryptic species is increased. Variation in the effort with which a given census method is applied at different times and locations can therefore bias the results. Setting and ensuring adherence to clear protocols during a large-scale study helps to reduce this effect.

Habitat

Species vary in their detectability between different habitat types. For example, numerous studies have shown that many species are more detectable in open habitat than closed or complex habitats (e.g., Richards 1981; Bibby *et al.* 1992; Choquenot 1995). The selection of microhabitats for the placement of small mammal traps can also affect trapping results (Norton 1987; Stewart 1979). These effects are not an observer effect alone but are strongly related to heterogeneity and complexity of habitat structure. In some circumstances it may be possible to correct for this source of bias during data analysis (e.g., Burnham and Overton 1979; Southwell 1989; Boulinier *et al.* 1998) but only if relevant information is accurately collected from the field.

Species

Characteristics of species can create problems. Aspects of the behaviour of individual species or different reactions by parts of the population to the presence of observers or the detection and trapping method are frequent sources of bias. Correct species identification is also critical to data quality and may be complicated by the presence of cryptic or difficult-to-identify species or species groups. These effects can be mitigated by thoughtfully selecting one or more census methods to target species of interest, and by providing species identification resources and training specific to the needs of the study and the diversity of knowledge and experience amongst observers. Differences in species detectability can sometimes be corrected during data analysis (e.g., Krebs and Boonstra 1984; Boulinier *et al.* 1998).

Season and time of day

There is a well-known time of day and seasonal effect for diurnal birds, microbats, invertebrates and many other species, including plant species. That is, detectability varies throughout the day or on a seasonal basis due to cycles of behaviour or activity. Detection cues, such as characteristic bird calls or flowers required for identification of a plant species, will therefore come and go. This is usually overcome by ensuring that censuses are conducted at the best time of day and, whenever feasible, the best time of year.

Weather and environmental conditions at the time of observation

Weather conditions will clearly affect the behaviour of many species making them less visible or detectable (e.g., animals remaining in nests or burrows during heavy rain), and can also obviously physically reduce detectability (e.g., detecting calling birds against the background of strong wind in a forest) (Bibby *et al.* 1992; Pacheco 1996). As noted earlier, it can also adversely affect the concentration and diligence of observers. Weather and environmental conditions at the time of observation should always be recorded.

Data management

Significant errors can arise at every stage of recording, collecting, collating, and transcribing data during a field-orientated study. To counteract this, it is important to establish data handling protocols that will minimise transcription or recording errors. This can be achieved through the careful design of field proformas and notebooks so that they are: (a) simple and easy to understand; (b) logically laid out so that the sequence of steps in data recording correspond to the sequence of the forms; (c) accompanied by quick reference guides to ensure that lapses in memory do not lead to gaps in information; and (d) providing sufficient initial training for those using the forms.

Some degree of error control is possible after the collection of field observations through the cross-checking and filtering of information by various means when raw data are entered onto a database. Rejected data need to be referred back to observers as quickly as possible to allow corrections to be made while memories are fresh.

In large-scale projects (those with many observers or a long duration) it is often necessary to assign someone the role of data quality officer (e.g., Weaver *et al.* 1996). People in this role are responsible for conducting checks of accuracy and completeness of field data sheets and the quality of database entry work. This needs to happen in a timely fashion so that observers and recorders have the opportunity to assist in correcting errors while the relevant events are fresh in their minds. Feedback from those responsible for ensuring the quality of work and the overall integrity of the study is absolutely critical. People cannot learn to improve if they are unaware of a problem and given assistance in finding a solution.

Another important aspect of data management is the critical need for sufficient resources to be committed over a considerable period of time to store and maintain data gathered from a community-based research study. This means that some form of organisational or institutional support is needed to ensure that continuity is maintained in data management resources, staffing and expertise.

Maximising data quality

Selecting the most accurate, precise and least biased observation method is the first consideration that can be made to maximise data quality in any study, no matter what mix of skill-levels exists amongst those involved (Greenwood 1996). In any study involving observations of species in the wild, the primary need is to control or, if possible, eliminate as many sources of bias as possible. Every effort must be made to account for bias in the design and conduct of field work or in the subsequent analysis of results. It is also very important to accurately record all possible sources of bias that are not explicitly accounted for in the study design. In this way it is possible make some adjustments for their impact when data are analysed. Again, it is worth stating that professional and non-professional alike are prone to many sources of bias.

Data quality is maximised when data are collected with high accuracy and precision, bias is minimised and data handling errors are infrequent. The most effective means of maximising data quality is to gain everyone's commitment to adherence to clearly defined standards and survey methods, and provide necessary training and feedback.

People management

Although essential for attaining a satisfactory degree of rigour in community-based research, people management is probably the most challenging area. It seems reasonable to expect that the quality of the results will be directly proportional to the effort put into communicating, inspiring and instilling commitment and understanding in partici-pants' minds. This needs to be achieved with a diverse cross-section of people who must be built into a team.

A shared vision

Like any other undertaking with many players from diverse backgrounds, it is essential that everyone involved in a community-based research project has a shared vision of the aims and objectives, and has agreed on the means for achieving them. There needs to be a common language developed between partners.

Communication

Interpersonal communication skills (*sensu* Bolton 1987) are critical to success with community-based research (Trauger *et al.* 1995). The media used and the form of communication between partners need to be given some thought. Small projects can be dealt with mostly by face-to-face communication. Larger projects will require diversification into other forms of communication such as newsletters, local or regional electronic media, or the use of the Internet and e-mail. Scientific experts involved in these exercises must work hard at translating scientific information into a language that all can understand, and provide information that is relevant to group dynamics and decision-making (Bolin 1994). For example, in large-scale projects it would perhaps be valuable to have a regular update on the accuracy and precision of the survey results relating that to the work being done by the dedicated people participating in the project. In this way, concepts such as scientific accuracy and precision of measurement become linked to the personal effort of all involved.

Feedback must, therefore, be a major feature of the communication process with the group or team working on a community-based research project. This is particularly so between scientific experts and other partners for this is the way in which progress towards your shared goals can be judged. It is an important means by which the diligence of a diverse cross-section of people can be maintained thus raising the scientific value of the project. However, feedback must be a two-way communication process and the scientific or technical experts must be open to feedback from other team members.

Ground rules

Successful collective activities, such as community-based research, must depend upon some form of social cohesion. Ultimately this arises from shared goals, the development of trust between partners and a history of facing challenges together. But in part, this must be due to acceptance of basic ground rules for acceptable and ethical behaviour (Schwarz 1994). Often these ground rules need to be stated openly. For example, volunteers participating in research field trips may be required to sign a commitment to rules of conduct (e.g., NPWS 1997).

Personnel turnover

Regardless of how careful you are in recruiting, training and motivating participants, you must expect, and thus plan for, a relatively high attrition rate in longer-term studies. Out of your initial group, only a few will be interested and capable enough to see it through. Also allow for a slow start as people get used to working in the way required by the study design and the census methods you must employ. These considerations lead to highlighting the value of organisational or institutional support in managing community-based research studies, for that can provide the infrastructure ensuring continuity in the face of high participant turnover.

Team building, training and support materials

Adapting a view expressed by Toffler (1974), the nature of a training problem defines the nature of the learning process. Clearly, working with community groups in a collaborative activity indicates group activities and learning methods associated with them. Well-directed or managed group processes are extremely effective learning environments because the internal social interactions reinforce and reward learning (Toffler 1974). Thus, professional scientists engaging in this kind of activity should learn to manage groups. Group dynamics is a very real process well-understood these days by social scientists and psychologists. Team building is another way of expressing this process. Building a successful team involves developing common objectives and a shared language to express them in, and building trust and respect for one another. There is ample material to assist those interested in this aspect of collaborative, community-based research ranging from shorter, introductory articles or papers (e.g., Pomerantz and Blanchard 1992; Parker 1994; Schwarz 1994; Daniels and Walker 1996; Weaver *et al.* 1996) through texts (e.g., Nolan 1987) to short training courses (e.g., NSW Volunteer Centre).

A further advantage of the group-based activities inherent in community-based research is that it naturally forces everyone involved to address the many factors and points of view affecting biodiversity conservation in a way that integrates scientific data gathering and analysis with policy, politics and other subjective sets of values. As Toffler (1974: 17) noted "members of a small group working together to bring about some change in the ecological condition of their community, for example, will find they must learn something about science, economics, sociology and politics, as well as the communicative skills required to define the difficulties, outline alternative solutions, and persuade others".

Adult and experiential learning principles represent another approach to this matter of working with a diverse cross-section of the adult community on collaborative ventures. Again, there is a wealth of material to introduce the novice professional scientist to this subject (see Daniels and Walker 1996; Howard 1996; Rogers 1996; Tight 1996).

Training for professionals

The importance of communication skills, team-building and adult education to conservation biologists is widely acknowledged to be high. Some also bemoan the lack of training in these skills given to professional scientists (e.g., Wren-Lewis 1974; Gilbert 1988). The current debate over the value to conservation of community-based research serves to again highlight these points.

Underpinning it all must be a recognition by scientists that their role as an expert in community-based research is that of an intermediary with a knowledge of the world of science and an understanding of the needs of community members in a research team (Corbett 1970). Carrying out that role will require considerable insight and effort (Bolin 1994; Franklin 1995).

Keys to success in community-based research

An extensive literature review (Wilson 1995), combined with subsequent personal observations, leads me to propose that the key attributes of successful community-based conservation programs are:

- they are outcome or process orientated rather than product or output orientated
- they are flexible, adaptive, pluralistic, accepting of cultural or attitudinal diversity
- there is equitable sharing of costs and balancing of benefits
- they involve the formation of equal partnerships leading to empowerment of community members
- they undertake institutional strengthening aimed at local stewardship of resources
- they involve community members in conservation planning, research and monitoring and these are integrated into community activities.

Some relevant examples of community-based research programs that have been implemented in accordance with many of these attributes as principles or objectives include:

The Swan Coastal Plain Survey (Keighery *et al.* 1995)

Nature Mapping in the USA (Dvornich *et al.* 1995)

Salamander Monitoring in the USA (National Biological Survey 1997)

ReefBase "Aquanaut survey" of coral reefs (ICLARM 1997)

Bird population monitoring in south-western Australia (Saunders 1993)

Land degradation measurements in Victoria (Martin 1995)

UK butterfly monitoring scheme (Pollard and Yates 1993)

UK National Bat Monitoring Programme (http://www.bats.org.uk/nbmp.htm)

Every one of these apparent successes is a fruitful collaboration, indeed partnership, between professional scientists and interested community members. However, community-based scientific investigation is not a panacea. As I see it, it is not an essential or must-do task for all professional conservation biologists. Some scientists will be better suited to using this approach than others. Some will misjudge the situation and ask too much of interested, but untrained, people. This may lead to a failed project. It is a useful adjunct to formal academic scientific studies, another valuable tool. Like all tools, it can be used with skill to yield results not possible by any other means, or it can be used inexpertly with unfortunate consequences.

I believe there are excellent examples to show that, with careful judgement about the survey methods used and diligent people management, it is possible to engage members of the wider community, of which professional scientists are a part, in some form of scientific research to the benefit of all. The clearest benefit I see from the effort professional scientists put into wider participation in some form of scientific research is the development of an informed, knowledgeable support group who can become a more effective positive force in conservation and natural resource policy debates: in effect, a pro-science constituency.

If you:

- have a question that can be answered by a straightforward and robust method,
- need extra hands to do the work,
- are prepared to invest heavily in supervising, training, motivating and communicating with a wide cross-section of people, and perhaps extend yourself by first learning some new communication and people management skills, and
- in addition to the scientific value of the project, you see great social or political benefit in that kind of intense educational process,

then *do* consider becoming involved in community-based research. If you answered "no" to any of the above, you will be likely wasting your time and everyone else's!

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QUESTIONS & ANSWERS

TIM GLASBY: I am just interested to know some examples you might have of situations where biased, unrepresentative and inaccurate data can be useful.

WILSON: Can you clarify your question?

GLASBY: You were talking about observer-biased, inaccurate data; blah, blah, blah. You were talking about the problems with data collected by community groups, which you emphasised many times.

PETER WILSON: Some of the statistical techniques that have been investigated allow you to make corrections for detection probabilities for certain species, so you can calibrate the detectability of species. You can make allowances in your analysis for that. They rely more on presence/absence or presence information, rather than trying to quantify relative abundance or abundance information. So you are not actually trying to count how many weevils he saw, but that weevils were present.

The sort of statistics that I was referring to trade breadth of coverage for intensity of survey. If you have many observers observing across a wide area, the sorts of analytical techniques that I'm referring to are those that Ross Cunningham at ANU has been looking into quite intensively for the purposes of improving the quality of information coming out of the Australian bird count scheme. You can actually make some inferences about abundance of species based on presence/absence information. That is the sort of thing I am referring to.

The most important thing is to minimise bias and minimise observational errors due to different operators: different observers, different observational errors. That is why I suggested that one of the keys to success is engaging people in community-based research projects where the techniques will minimise that problem. The important point to remember is that even scientists are prone to bias and operator errors. I first became aware of this as an undergraduate student trying to measure bat skulls. There are a number of papers which show quite clearly that even skilled and experienced people will come up with different mean values for a particular measurement, simply because different people hold calipers differently, and they are professional people; they do this sort of thing for a living, measuring bones. But two different groups of operators came up with two statistically different values. That has been also been shown in biological survey work but there are ways of accounting for it in statistical analysis, and in the design of the study.

ARTHUR WHITE: I will just elaborate on that a little bit, Peter. With the frog and tadpole study group we have been involved in a lot of frog surveys, particularly around eastern Australia. One way we have tried to overcome observer bias or misidentification is that all sites get surveyed by at least two separate teams and we compare data from the two teams. That has been very useful in picking up all sorts of information, like which species are being readily detected as opposed by those that are being regularly missed.

PETER WILSON: Yes, that's a technique that I forgot to mention, in the sense of designing a survey that tries to account for those kinds of problems. That's quite a common approach and a very valuable one too, because although it means visiting the site twice, it does mean you have a cross-check based on direct observation. You don't have to resort to statistical corrections.

ARTHUR WHITE: We found we had to do it even with team leaders, where we had people who were experienced herpetologists, we had to do dual visits.

PETER WILSON: That's right. I can relate some horror stories from multi-million dollar forest biodiversity surveys, but I won't at this juncture. I don't work for that organisation any more.

NANCY PALLIN: I wasn't actually directly involved, but part of trying to see what was going on with the bat colony at Gordon was weekly counts. One of the best things was that, monthly, the person coordinating it actually did a little newsletter about what the counts were, what it meant, any interesting or extraordinary things like the odd frogmouth, and this kept people's interests going. You mentioned feedback, but what kind of feedback, and how often, and what is it that people want to know? The first eastern Australian flying-fox count was attempted recently, and we are all busting to know what the next one will be.

PETER WILSON: Actually, that is a good point which I did gloss over. I don't think there is any hard and fast rule, and there is no formula that I have come across or had any experience with, that says that you should send out this form of feedback weekly, and that kind of feedback monthly. The general principles I have come across are that you provide as much feedback as you possibly can, as often as you can and, as Sue Briggs mentioned, it's a two-way process. You take feedback in and you give feedback out.

Newsletters may be one way of doing it. If you are involved in a major regional study, as Denis Saunders was, you use electronic media. NPWS in New South Wales has done similar things. They have used mail-outs, and they have used door-knocking. They have gone on regional radio and television to explain what they are doing. In other words, you have to basically build the communication strategy. I don't want to sound too bureaucratic about that because I am no longer a bureaucrat, but you really do have to plan ahead and think about how you are going to talk to the people that you are trying to reach or that you are engaging in your project, and how they are going to get back to you.

You need to look at a whole range of media, and a whole range of techniques for communication. They can be newsletters, they could be an internet site, they could be radio bulletins every now and again on community radio, whatever; workshops, seminars, meeting down the pub, whatever. In fact as Sue Briggs pointed out, quite a lot of important things are learned in that two-way communication process, either over a cup of tea or at a barbecue on somebody's property out west.

The most important thing to feed back is "how are we going", and as the information might start to flow in, "what impact are we making?" You might also address questions like "what headway are we making towards our agreed and our shared goals and objectives?" That's why I stressed earlier that you really do need to sit down at the start and plan how to communicate with people about what it is that you are trying to achieve, how you are going to get there, and let people know how you are going towards those goals. That, I suppose, is the message that has to come through in the feedback process.

COURTENAY SMITHERS: I think one of the one most important things in this kind of feedback business is in fact to, if possible, establish an individual, personal type of relationship with your cooperators. If Mrs So and So sees So and So in the next newsletter look, say you know So and So saw this, or did this. This brings them in to a very personal relationship with you or the organisation or whatever you have.

There is no question that that stimulates other people to send you snippets, which might not come through formally if they are sending their data back on sheets or whatever. It stimulates them to write a note and say, "Look, you know, I have seen this and this, and Joe Blow down the road has seen this". I found when I was running my butterfly migration scheme - which went for 12 or 15 years and at one stage I had 400 cooperators - and it was always this kind of personal inquiry or this personal response which gave us the most detailed and quite often quite significant information; information which was not covered by any formal request or any formal way of returning the data to us.

PETER WILSON: That's a good point. I think it is something that has come through a number of speakers today. It is the most personalised form of communication that does bear fruit, and certainly builds, within the group that you are working with, a team spirit and an understanding of each other. It really does make it something that they can see value in too, in a personal sense; not in a scientific sense but in a personal sense. Their contribution is noted. Their contribution is valued.

COURTENAY SMITHERS: And there is value for other people in the system as well.

WILSON: Yes, that's right. The broader sense of contributing. Yes.