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Multiple communities: botanical data from citizen scientists for digital repositories.

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Abstract: This paper describes the data-managing activities of members of the Australian Plants Society of Victoria, a well-established organisation of volunteers with a passion for Australian plants and conservation. Four recurrent themes emerged from a research project, showing commonalities between the attitudes and behaviours of this community of citizen scientists and other communities which rely on information and communications technologies for community development and for community archives. In this study semi-structured interviews and a survey revealed the current data storage and management practices of the APSV, what current attitudes exist to sharing, whether such practices and attitudes facilitate extensive sharing of research data, and suggestions as to how to improve skills and technologies for making further contributions to large digital repositories. The project is continuing.

Keywords: Citizen science, data management, community informatics, community archives

Scope, purpose and value

For centuries groups with a love of nature have marvelled at, collected, classified, written about and publicised environmental phenomena. The very term 'plant community' incorporates connotations which are analogous with the essence of a community of humans, networks, or archives: it means an ordered collection of interdependent species occupying a specified space and period of time, a more or less homogeneous grouping distinguishable from other vegetation types. Many internal and external factors influence the welfare and environment of plants, such as topography, climate, soil, human interference, and others.

Following this scoping introduction, this paper describes our research approach and its implementation, relevant key terms and concepts which require clarification, and our main discoveries in a project with the Australian Plants Society Victoria (APSV). A large part of the paper deals with four themes which emerged from the first phase of a two-phase project, an ethnographic case study, which was undertaken in 2011. These themes, which connect with the scholarship of community informatics and community archives, are: a lack of expertise on the part of APSV members in the use of information and communications technology; concerns about data quality; the relationship of citizen science to mainstream science; and the differences between local and global communities of interest. This paper makes no pretence to compare the underlying philosophies or ontologies behind community informatics and community archives, worthy as such endeavour may be, but the paper aims to highlight common practical issues which concern both, as demonstrated by our reported ethnographic case study of one environmental voluntary organisation. Coincidentally these issues of themselves may relate to common philosophical underpinnings, and it is possible that they may provide some basis for future discussion.

In the past, individuals kept records for their own interest; they were not managed for extensive archiving or unlimited dissemination. Recently concerns about the health of the

earth's environment have magnified scruples about the need for more widespread collecting activity, the reliability of data collection and published observations, the need to account for the context of scientific data, and the resource requirements of long-term global scientific studies. Volunteers are cheap (Devictor, Whittaker and Beltrame 2010). On the ground, the communities which engage with orchids, mosses, fungi, moths, butterflies, dragonflies, reptiles, frogs, spiders, birds, threatened species, weather, fish, whales, the ocean, coral, shells, galaxies, and hosts of other things worldwide, may or may not share their precious (sometimes unique) data. Many factors motivate communities.

This paper discusses the problems with regard to management and sharing of valuable plants data, which emerged in the first phase of the APSV project. The four research questions which provided the focus for the original data collection in 2011 were:

1. What are the present data storage and management practices of APSV members?
2. What are the advantages and disadvantages of these practices for the sharing of research data?
3. What are APSV members' present attitudes to sharing research data? and
4. What can be done to encourage APSV members to share their data and to empower them with skills and technology to contribute to major data repositories?

Research approach and implementation

The researchers used an interpretivist/constructivist approach. As implied by the questions, above, initially the research team aimed to discover how volunteers in the APSV were collecting their field data, what technologies they used, whether they shared data, how they managed and curated their collections, and whether ICTs furthered their endeavours. Interpretivist researchers emphasise natural settings and seek to gain deep understanding of the meanings of the actors involved in the social phenomenon under study (Williamson and Johanson 2013). This project tried to identify the shared meanings of participants about their experiences but also took note of the individual meanings emerging in different attitudes and approaches. Such a process required the researchers to look for both consensus and dissonance. Within this framework, the method was broadly ethnographic in style, aiming to describe the various behaviours and approaches of the participants (Kennan, Williamson and Johanson 2012).

The interview sample consisted of 15 members of the APSV, purposively selected (Patton 1990) to include those who were active in data collection, management and storage in the immediate past. A 2007 survey of APSV members (Hempel 2007) guided the formulation of criteria for selection of interviewees to some extent. For example, the recruitment of mainly older participants was in keeping with the age profile of the organisation, 80% of whom were over the age of 50 at the time of the survey; and gender proportions reflected those of the Society.

Recordings of the interviews were transcribed word for word. Analysis was influenced by the 'constructivist grounded theory' approach of Charmaz (2003), and involved detailed categorisation and coding of the data within key themes as they emerged during the process. The analysis was done by hand, rather than by using computer software. To link themes and categories to key quotations that might be used to support the findings, a device known as a 'voice sheet', was set up for each theme. The voice sheet focused on the quotations ('voices') of participants, and a summary of the meanings on each voice sheet was written after the series of entries were completed.

As a follow-up to the interviews, and in preparation for this first phase, a survey was undertaken. Between February and April 2013 APSV members were requested in their newsletter to complete an APSV online questionnaire about what equipment they used to

collect data on field trips, where they stored the data after collection, how they secured it, whether they would like to borrow handheld equipment if it was available for loan from the APSV, and whether they wanted to be trained in information literacy. Encouragingly, the 101 responses tended to reinforce the conclusions already drawn from the interviews.

Some quotations from the interviews and some statistical data from the survey are highlighted in this paper, where they assist in providing strong evidence of general themes.

Key terms and concepts

A few terms require clarification in order to explain the parameters of this study. The terms are: community, the APSV, data, and community archives.

Community

Many names are used in the literature to describe communities of nature enthusiasts. One is 'community scientists' (Wiggins and Crowston 2011). With varying overtones of approval or formality, the other names are citizen scientists, networked scientists, public participants in scientific research, environmental citizens, lay volunteers, amateur scientists, natural historians, environmental volunteer groups, volunteer conservation officers, voluntary biological monitors, and eco-conservation officers. The phrase 'citizen science' was coined in the USA in the 1990s (Rosner 2013) and is little known in Australia, but in any case all of the above names describe much the same group. Citizen scientists can be defined as non-professional volunteers who collect, analyse and share natural data, using some technologies. Although it has been asserted that the term citizen scientist is increasingly used for those who participate in formal projects directed by professional scientists (Brossard, Lewenstein and Bonney 2005), it can properly be applied to the volunteers who take part in the data collection activities of an environmental voluntary group such as APSV with no hierarchical supervision.

Some writers assert that citizen science is about to become a new discipline, incorporating science, social science, database management, learning theory, education, computing, and botany (Bonney and Dickinson 2012). A challenge arises if multiple epistemologies are to be countenanced in a new field such as this. For instance, indigenous communities often understand the natural environment better than invading cultures with their hegemonic portrayals of flora and fauna (Rosner 2013). Although it is not the aim of this paper to explore the detail, it is worth alluding to the approach of indigenous Australians to the natural environment as a contrast with more familiar ways of thinking. It may be worth exploring at a later date. Indigenous nature is not separate from human culture, nor external to human activity, but is integral to all life:

The land, and how we treat it, is what determines our human-ness. Because land is sacred and must be looked after, the relation between people and land becomes the template for society and social relations. … In other words, every Aboriginal person has a part of the essence of one of the original creative spirits who formed the Australian landscape. Therefore each person has a charter of custodianship empowering them and making them responsible for renewing that part of the flora and its fauna. The details of this metaphysics varied widely across the land with the physical environment, but the spiritual basis—the understanding that what separates humans from animals is the fact that each human bears a creative and spiritual identity which still resides in land itself—provided and still provides in many places the religious, social, political and economic force throughout Aboriginal Australia (Graham 2008 p. 182-183).

It is worth noting that respect for indigenous beliefs, and ways of knowing, have long been part of the credos of community informatics and community archives (Clarke 2008).

For this paper, the term 'community' thus encompasses groups of people with shared interests – whether the interests are based on discipline, profession, hobby, passion, spiritual allegiance, ethnic identity, or cultural origin.

The APSV

It is estimated that there are more than 5,000 environmental community organisations in Australia (Dhakal 2011), and maybe 2,000,000 worldwide (Hawken 2007), of which the APSV is one. It is a state branch of Australian Native Plants Society Australia (ANPSA). ANPSA (Australian Native Plants Society Australia 2013) has 25 Study Groups which focus on particular genera (e.g., acacia, correa), and which undertake more scientific activities. Most important in the APSV structure are the district groups to which there is strong local loyalty. The APSV (Australian Plants Society Victoria 2013) has approximately 1,700 members (Hempel, 2007; Walter, 2007).

The APSV has been described unfairly as a 'tea and biscuits club' (interviewee 15). In truth it is an exemplar of an environmental society, 'a vibrant organisation' (interviewee 4), involved for 56 years in 'breeding, researching, collecting, showing, arranging, observing, photographing, drawing and conserving' native plants, as the official history of the Society explains (Walter 2007 p. vii).

The Society members characterise their association as having much-respected local community attributes. They appreciate a sense of belonging to a group with shared values, interests and behaviours; they firmly identify with conservation causes; and face-to-face connection on a regular basis is more important to them than virtual networks. Emphasising the value of links, many APSV members belong to other like-minded groups such as the Field Naturalists' Club of Victoria (started in 1880), the Victorian National Parks Association (1937), the Cranbourne Botanical Gardens (1970), the Australian Flora Foundation (1976), the Indigenous Flora and Fauna Association (1986), the Australasian Native Orchid Society (1968), and various Land Care groups. It is not uncommon in community informatics projects to find that when groups are firmly grounded in person-to-person connections, then online networks extend these connections effectively and build further social capital (Economic and Social Research Council 2006; Stoecker 2002).

The APSV is typical of many voluntary environment groups in Australia and elsewhere. Although association activities are focused on local concerns, and local links, the cumulative impact of such commitments ultimately assists global conservation.

Data

There is a strict taxonomic hierarchy for describing categories of the Kingdom of Plants -- Phylum, Class, Order, Family, Genus, and Species -- which is already well known to the volunteers. The main types of data collected in the field are photographs of identified plants, followed by plant locations, habitats, insect pollinators, birds in the area, seeds, height of the plant, date and time of the observation, specimens, and plant growth patterns. It is not unusual for an experienced volunteer to compile a list of the species in a given area, which is distributed to associates for checking off, and adding to. Since the 1970s interviewee 5 has been adding to a list which now fills six pages of fine print.

Community archives

From the perspective of community archives, it is important to note that APSV members sell plants and propagate them in their domestic gardens, which in themselves

become a living record (interviewee 9 had 4,500 different plants in his garden). Interviewee 8 knew

one of our members of the Maroondah group [who] records what happens in his garden. He keeps … a weekly record sheet … plant by plant, … and he has shared [knowledge] in newsletters … and put out data sheets for members if they want to keep records in the same sort of way [to help to identify climate change].

Other members have refrigerators in their garages for storing specimen cuttings which they intend to identify, to represent as botanical drawings or paintings, and/or to plant. Interviewee 7 swears that plants cuttings take precedence over camping food supplies when cool space is at a premium on a long collecting trip. Another form of record is collected seeds which require precise provenance to be of any use. Interviewee 11 manages a seed-bank for regeneration of grasslands. Such collections constitute unconventional archives.

The content of a community archive in the past frequently referred to cultural heritage artefacts, traditionally attached to a geographical place. ICTs have expanded the breadth and depth of collections and communities inexorably. By combining bioinformatics and cyber-infrastructure with good metadata tools, the archive becomes '*the* reference version of the data and thus the basis for all subsequent work' (Kelling 2012 p.62). In this study the community archive may extend from a personal collection of a few dried plant pressings inside an old telephone book to contributions to global digital repositories. All our volunteers are committed to common conservation ideals (Latimer 2006).

Among volunteers, connection to and experience with other organisations stimulated serious attention to useful archiving practices. Interviewee 8 took special pride in her care of her domestic data collection: she and her husband 'are both people who like to file things away neatly; we both have professional office backgrounds'. Members of Birds Australia (now Birdlife Australia) developed similar record-keeping skills as a result of belonging to that association (Weston, Silcocks, Tzaros and Ingwersen 2004). With ICTs there is an opportunity to communicate field data with the other side of the world instantaneously. Thus interviewee 4 built up 'a real friendship' with the Santa Cruz Campus of the University of California, in an exceptional way, by assisting it in the construction of an arboretum of Australian plants. As a result 'they did some really good research [in Santa Cruz] in a way which we had not done' in Australia.

Australia's largest community archive, the national Atlas of Living Australia (2013) is virtual, bringing together traditional physical collections (such as herbaria) and born-digital data (such as sightings of locusts on BowerBird 2013). What the digital repositories have in common is the global standardisation of the data and metadata, and the remarkable accessibility of the data to multiple community groups. A few interviewees were interested to upload data in a quick, user-friendly, transparent way, but only where the volunteers were acknowledged and could see their contributions. The Atlas of Living Australia had only recently been released at the time of the interviews (2011) and was not well known amongst APSV members. One adventurous interviewee had developed a database, named NatureShare (2013) particularly for the APSV, which (surprisingly) few of the other volunteers had attempted to use. To move into the second project phase, described in the conclusion, the research team has chosen to explore volunteer interactions with two digital repositories, BowerBird, and NatureShare, as recent and dynamic examples of community flora and fauna archives. The data from BowerBird and NatureShare are uploaded to the Atlas of Living Australia, thus providing an indirect link between volunteers and the Atlas.

On the basis of our discussion, a community archive includes preservation by a community of objects for long-term conservation purposes, using technology to share objects and knowledge-representations of them with like-minded collectors, and making use of

newly-formed virtual repositories. In academic reflection on community archives, often a marginalised community creates the archived collection under scrutiny, which is part and parcel of that community's claim for respect for self-identity. As for our APSV members we must conclude that they spiritedly connect their own patch with a global environment movement.

Main first-phase findings

This section summarises the results of interviews with APSV members over four months in the first half of 2011.

For an APSV member a typical day or night excursion into the field involves someone alone, in a pair, or a group of up to 10 volunteers, often from the same district or study group, who go out to observe, note, and photograph plants and their environs. One experienced member may act as leader, another as recorder. Equipment will usually be a camera, Geographical Positioning System (GPS), a recording device, or notepaper and pen. The chosen territory may be fresh, or it may be the subject of ongoing longitudinal analysis. Members may be joined by non-members with a special interest. Interviewee 11 described endangered grasses alongside a railway track. She formed a recovery team, which was accompanied in the field by a regional manager from the Department of Sustainability and the Environment, the railway operator, the owner of the land, and staff from nearby nurseries.

Interviewee 11 went on to point out that

it's really nice to go with a group because other people actually spot things, so you've got more sets of eyes looking. … We do wildflower walks. … I've only ever seen one striped legless lizard in the wild, and that was because there was a group of us and we could make a circle around it.

Typically the collected data were uploaded to a personal computer at home, sometimes turned into a digital slide presentation and/or talk, or a newsletter article, for a wider audience. Interviewee 9 ran a plant radio show and was 'doing many talks':

I'm doing one at Bendigo. I did one last night at Kilmore, tomorrow I'm out at … Hughesdale or wherever, that is for a talk, and then on the weekend up at Kallista.

Our studies into the collection, management and transfer of botanical data and knowledge showed that the processes were constrained for many reasons. Existing practices had clear limitations.

Technology is just beginning to have an effect on collection of data in the field. Awareness of the potential of mobile devices and the value of the integration of technologies was evident, especially in the 2013 survey. Of the 15 interviewees in 2011, 11 owned a mobile phone, but only one used it for plant purposes; by the time of the survey in 2013, 13 (39%) of 33 respondents (to a question about technology used in the field) were using a mobile device. There was no crowdsourcing, but almost every volunteer used a digital camera. It was rarely linked to a GPS, although the survey showed a tendency towards adoption of automated connection between the camera and GPS (in the case of three respondents). An awareness of the constraints of current practice was evident; in the survey, 51% of respondents said that they would use a combination if they could borrow the equipment. Eleven survey respondents claimed to use smart phones for data collection, and one used an iPad.

In spite of much-publicised global efforts to create umbrella applications and large-scale repositories for the collected botanical (and ecological) data, the large repositories held little appeal for almost all APSV interviewees. Yet by the time of the 2013 survey, 23 out of

25 respondents to the relevant question professed to want to learn about making good use of the repositories. For volunteers home computer storage was still the norm. Wikis were not used.

From the interviews it was clear that members had not adopted systematic methods to co-ordinate their botanical knowledge. Printed sources of knowledge were far more popular than online resources. Collectors still relied heavily on handwritten notes for storage, and personal memory and personal computers were universal props. They were prolific publishers of books, catalogues, lists, newsletters (in print and electronic form), and field guides. Interviewee 6 described the popularity of her own book:

That book … is in its fourth edition now and I was at a nursery recently, down at Williamstown, and somebody asked me the name of a plant. … I said, 'Damned if I know, some coastal thing', and the [nursery]-owner came out with [my book]. I've never seen a book so dog-eared. … Literally it was a wreck.

Photographs (and their captions) were universally popular for storing vital data; interviewee 3 estimated that APSV members have photographed about 98% of all Victorian plants. Personal archives varied from old coloured film slides to online images transferred to memory sticks and CDs. Understandably, each individual aspired to maintain high standards of data cleansing and verification, but such endeavour was difficult to sustain in isolation. There was a sense of impotence about lack of agreed measures for quality control. Local knowledge was respected and prized, so proximity of a source to a geographical collecting place was regarded as the most reliable determinant of accurate data.

Personal networks were relied on heavily. Personal fulfilment, mental application, and acquiring broad conservation understanding were the strongest motivators for joining the APSV community in the first place. Unsurprisingly there was a strong ubiquitous culture of sharing willingly and freely. Interviewee 4 discerned community building in that

you've got like-minded people in most cases and there is a really good sharing of information between those people. Nearly all of them are really willing to learn about things; some are there purely for social activities but a lot of them are keen to learn. … Initially it was growing [plants], but people then wanted to know where [the plants] all came from, so there's a lot of bush trips … and there's special interest groups.

E-mail and websites were treated as extensions of personal networks for sharing with like-minded enthusiasts locally and internationally. The group habit of sharing knowledge was revealed only in relation to plant data, though, and not to sharing of know-how about new methods of storage and retrieval of data. Although glimmers of curiosity existed (interviewee 12 could 'see people [using technology], so I want to do it myself'), technology was not discussed much in the APSV. While there was widespread understanding of the power of ICTs in principle, the advanced age of many members, and concomitant lack of computer literacy, caused potential obstacles to speedy communication and good archival practice. Mobile devices, specially-designed applications, online forums (e.g., blogs), subject databases, and smart phones were just starting to be used by a small minority.

Common themes of concern to the plant communities

Several significant issues which occupy the minds of citizen scientists emerged in our study of the APSV, which are also topical in the disciplines of community informatics and community archives. In the remainder of this paper we set out the themes, their relevance to community informatics and community archives, and possible solutions to the problems which presented themselves in our case.

Technical competencies

A commonly-mentioned problem was that a lack of technical expertise among volunteers prevented proper interaction by APSV members on a local or global level. Interviewee 9 pointed out that the age of

the group of the members … is generally from 55 or 60 onwards. There are probably only five per cent of people below 55 … so the people there are not really interested in technology, and it's very hard to communicate with them via email. It would make everyone's life easier.

The same age sector predominated in Birds Australia (Weston et al. 2004). Interviewee 7 was concerned by the potential loss of knowledge and experience when the older generation disappeared:

The biggest problem you've got in the Plant Society is that they are all old. … They are not using [online] information. … A lot of the older ones … have got fabulous information … because they've been out there in the bush for so long, … fabulous information but they are just not computer literate. … Now in 20-30 years that'll change.

But regardless of age, interviewee 3 asserted that 90% of APSV members wanted to share their data widely 'in a useful way, and can't' because of the lack of user-friendly, freely-accessible digital repositories. The organisational dilemma is whether there is a dearth of systems or motivation. Obvious benefits of basic sharing online were appreciated by interviewee 13:

[With] information shared with the modern Internet and computers there is an opportunity to share things which just were not possible before. All sorts of things could be published at very little cost.

In addition, interviewee 11 insisted that attractive representation of data online was essential in order to attract use:

I think that NatureShare is making me discover something of myself in that, whatever you put in there, it's got to come out in a way that is going to be attractive to people and make them come back.

So the potential benefits of digital literacy are appreciated, even though on the whole the practical know-how was missing at the time of the first phase of the study. It has been found that technologies which stimulate and enthuse volunteer citizen scientists are likely to elicit greater commitment to environmental projects in the USA (Newman, Wiggins, Crall, Graham, Newman and Crowston 2012). The same principle of stimulus operated in a community informatics study of butterflies in Taiwan; it enlisted the dedicated support of virtual volunteers (Ho 2006). A community archive in Brighton in the UK managed to attract hundreds of volunteers by promising to provide them with training in computer literacy and communications skills (Community Archives Development Group 2007).

Our study into lack of technology literacy in the APSV supports the balanced recommendations presented in the thorough review of voluntary organisations reported in 'Doing IT Better' (2010):

To take advantage of ICT opportunities, NFPs (Not for Profits) need the resources — funding and skills — to develop, purchase and implement ICT solutions. They have to see that such investments will bring about not just productivity improvements but better outcomes for … members [and] participants. … While resource constraints explain slow adoption of ICT for many NFPs, some are reluctant to adopt new technologies where

these alter control over information or valued traditional approaches. Training and support for implementation of ICT solutions should be part of capacity building programs (Stillman, Kethers, French and Lombard 2010 p.96).

The community-building credentials of citizen science are strong. Prior studies have found that communities with a voluntary scientific interest participate more in other forms of community development, are more sustainable, advocate more for local issues, and have more influence on policy-makers (Conrad and Hilchey 2011).

Extensive use of ICTs is also likely to increase the quantity and use of scientific data. Our survey participants showed a strong interest (93%) in undergoing training in ICTs. Accordingly in the second phase of our project, the team will create a community ICT toolkit to promote learning and to train volunteers; such an approach is recommended by the Atlas of Living Australia (ECOS magazine 2010) and other environmental volunteer organisations (Newman et al. 2012). Technology has inspired collectors. The number of identified birds on the database eBird increased enormously when birders from all over the USA were able to compare their own lists of species with others' lists online. Up until then individual bird sightings were reported seriatim. By using a smart phone app for sharing, collecting took on the immensely popular element of a competitive game (Rosner 2013). Apart from providing attractive technologies, however, scholars of community informatics know well that grounded leadership and ongoing training and support of volunteers are vital elements of successful community networks (Williamson 2007). Continuing technical support is essential for sustainability (Dhakal 2011).

Data quality and data use

A second theme to emerge from our ethnographic research was concern about the quality of the data collected in the field. Apprehension about data quality was discussed by APSV members from two perspectives -- fear on their part of the consequences of publicising incorrect observations occasionally, and the patronising attitude of some serious, mainstream scientists towards all data collected by amateurs. As an example of the latter attitude, the US government in 1993 went so far as to ban the use of volunteer data collectors from the National Biological Survey (Kinver 2011). They have been labelled disparagingly in the UK as 'automated data drones' (Ellis and Waterton 2004 p.98). In relation to the avoidance of error, interviewee 8 admitted that

I get a little worried that we may be taking photos of things that aren't what we think they are (laughing). So what I'm intending to do is -- where we've got particularly a member within our group who's an expert on a particular field -- for instance we've got someone who's very good on eucalypts -- we would ask her to have a look and ensure that what we think that we're showing, is what we're actually showing.

Interviewee 13 pointed out that once an error is embedded in any information system, 'it's very difficult once you [create] a false record, to eradicate it'.

It is said that 'mainstream scientists' strive to privilege their own ways of knowing over other ways, with the result that the contribution of citizen scientists is devalued. Part of the scientific ethos stems from illusory faith in the objective and value-free nature of scientific enquiry (Hull, Richert, Seekamp, Robertson and Buhyoff 2003). At the same time, scientists realise that more and more extra collecting hands are welcomed for projects which depend on widespread observation. Increasingly, certain science policy and projects can only be achieved with citizen support.

One approach that some APSV members adopted as a solution to potentially false data was to use internal and external confirmation to cross-check observations. Interviewees

confessed that their own photographs were often checked against those available on Google. Interviewee 7 cited ‘a very, very popular little book’ called 500 Australian plants which listed all of the specimens that members brought to meetings of one Study Group to inspect and verify over a period of 30 years. It contained tried-and-tested collective knowledge. There was talk of increasing the number of plants in a new edition to 1,000. As another example of checking, interviewee 7 relied on the National Herbarium of Victoria, the ultimate botanical authority, described in tones of awe and admiration:

If I was sending a plant [to the Herbarium] … I would have the pressed plant and I would have a little piece of paper that says that I collected it; this is where I got it from; this is the date I collected it, the GPS or the longs and lats [longitude and latitude], and other plants that were in that area, so that it gives you an idea of the plant community and the major plants that are from there. ... What the [Australian] herbaria are now doing, it’s all been computerised, so all of that information then becomes available. Any comments, you know, some people write about the soil types, the other plants they are with, particular notes. [For instance] this is a male one, there was no flowering material, whatever. … I use them extensively in what I’m working on at the moment, … [that is] the book on the indigenous plants of Melbourne. With the one [plant which] I [deposited] … it was dioecious, which means there’s a male and a female plant, so I sent [the Herbarium] the two. So, one [botanist] said ‘This is the male’, and the other [botanist] said ‘This is the female’.

Clearly some comfort is derived from the fact that it is normal for experts to disagree sometimes. Note in this example that a judicious mix of specimens, handwritten notes, digitised sources, and print are used complementarily. Whether the collective sources are called a community archive, a personal archive, or a personal library, this volunteer does not discriminate between them.

In fact various recent tests show that citizen scientists produce data which are more or less of equal accuracy to that presented by specialists (Devictor et al. 2010, Gollan 2013). Jordan, Ehrenfed, Gray, Brooks, Howe and Hmelo-Silver (2012) report that ‘when compared to botanical experts who were not trained on the project protocol, volunteers were only slightly less accurate at collecting data’ (p 169).

Consideration must be devoted to data quality issues from the special perspective of the citizen scientists. Their view is seldom noted – let alone taken into account. Interviewee 4 noted with satisfaction that at least once botanists wanted

information on where certain plants occur. … So … we’ve been able to direct them because we knew [what they did not].

The reservoir of knowledge derived from the longstanding collective APSV experience is remarkable (Ellis and Waterton 2004). Interviewee 8 began collecting data in the 1950s, more than 50 years ago.

Large databases pose problems. The uses of data, as well as their quality, concern citizen scientists as much as mainstream scientists. Interviewee 3 expressed a view reinforced in recent literature that once data are uploaded to a centralised database, they disappear into a black hole, irretrievable later as individual entries (Ellis and Waterton, 2004). Understandably the collectors feel a strong sense of protection of data, having collected and cared for them, but they want to know how the data are used; the systems are not as transparent as good record-keeping ideally requires of them. Personal contributions are often not acknowledged at all, no matter how many resources have been invested in their nurture. In the UK the National Biodiversity Network is perceived by citizen scientists as undemocratic, not reflecting their priorities, and so they are reluctant to contribute to it (Lawrence and Turnhout 2005).

Insistence on the use of standard forms for data description by large digital repositories can insinuate impersonal and remote officialdom; in the field of community informatics the same straitjacketing of social welfare data is treated as an imposition by community welfare organisations (French and Johanson 2010).

If bureaucratic problems can be overcome, metadata should form a link between the case of the APSV and quality in community archives. Metadata adopts a taxonomy and describes data structure. Thanks to bioinformatics -- 'the development of data-management cyber-infrastructure' for biological data -- and botanical metadata standards, citizen scientists can effectively merge their data with data from others, and 'professional scientists' can analyse them easily (Kelling 2012 p.59). Assuming the existence of constructive collaboration between the citizen and mainstream scientists, the botanical archive becomes the authoritative version of the data and the basis for further research.

But tensions exist not only in relation to the quality of collected data and the usage of large databases. Disaffection is more widespread. Maybe it can be sheeted home to unfortunate experiences due to the negligence of bureaucracy, staffed by public servant scientists. For instance, interviewee 5 sent several decades of his collected data to a government database:

I wanted to get them registered somewhere so they could be of use [to others]. And it was just so difficult to give them. … You're not encouraged to do it because you get no feedback. … Like I'd sent them observations and two years later when I got the [whole database content back] … they weren't registered.

Relationships of citizen scientists and mainstream scientists

In the opinion of Ellis and Waterton, environmental researchers, such neglect of a contributor, as experienced by interviewee 5, should never happen; for them regular feedback mechanisms are an essential element of good database design (Ellis and Waterton, 2004). Part of the gap between amateur and professional is caused by the depersonalisation of data and lack of credit for their upload. The ingenious device of the Creative Commons is a simple answer to problems of overlooking fair attribution of citizen-created data in community archives, and the requirement for involvement of all community participants in devising and monitoring research projects is de rigeur in community informatics.

Collectors of citizen science data used in published research resent the fact that their efforts are not acknowledged. Realising their worth, scientists are beginning to advocate for the inclusion of the names of collectors in the attributions on scientific papers (Dickinson, Shirk, Bonter, Bonney, Crain, Martin, Phillips and Purcell 2012). A disillusioned bryologist (who studies mosses, liverworts, and hornworts) in the UK no longer contributes her data to national databases because of a serious breakdown in community trust:

A sense of resentment is gradually being born, based on the recognition that her data [have] passed through many hands and perhaps [are undergoing] a series of manipulations. … She notices that her data are being used more to raise the profile of conservation professionals than for 'real' conservation (Ellis and Waterton, 2004).

Whatever the possible causes of difference between the 'amateur' and 'professional', whether based on feelings of neglect, disregard, resentment, misrepresentation, or being patronised, growing evidence of shared values and actions between the two can be found.

Our interviewees were cautious about criticising mainstream scientists because many had built mutually-beneficial relationships with them over time. Interviewee 4, who became interested in native plants by running a nursery, co-authored an authoritative nine-volume

encyclopaedia of Australian plants with a professional botanist, and appreciated the value of sharing knowledge. He recounted how he learnt about ecology from mainstream scientists, they learnt where to locate specific rare plants from him. He described a valued organisational link:

> For a long time the Field Naturalists Club of Victoria used to be based at the Royal Botanic Gardens [RBG] and … rather sadly at one stage because of the redevelopment of the gardens, they moved out. … It means that there is still a pretty good relationship because even some of the professional people at the RBG [were] President of the Field Naturalists Club.

He added that botanists and zoologists published in the Club journal.

In 2008 in the USA 46% of citizen scientists were known to have a tertiary university degree of some sort (Cavalier 2009). Collective action by groups from a range of professional and business backgrounds brings them together; consensus is frequently expedient for managing a project (Triezenberg 2012). Interviewee 6 had no formal qualifications, but she knew 22 expert authors of botanical books personally. With no botanical academic background, interviewee 12 worked confidently with local farmers, municipal officers, neighbourhood politicians, and science experts to ensure that grasslands were managed sustainably. Interviewee 2 retired as a nurse and said that she maintained her evidence-based attitudes to the study of native orchids. In the case of the APSV, evidence of collaboration is stronger than disappointment or dissatisfaction.

The cited examples of co-operation between the amateurs and professionals indicate that the 'separation' may be due more to neglect and occasional rumour than entrenched bigotry. The mutual benefits of sharing knowledge are obvious to policy-makers in the UK, where the science-oriented Natural History Museum and the government agency, English Nature, have appointed facilitators to encourage smooth collaboration between each other, and communities of field naturalists, which are treated as indispensible (Ellis and Waterton, 2004). In the case of eBird in the USA, regional experts (both citizen and professional scientists) are appointed for checking data input jointly (Rosner 2013). In a conservation context, collaboration is far more likely to serve the common good than competition.

Glocalisation

While APSV is a tight-knit local environmental community, conservation has developed as a global social movement of concern to millions. The green aphorism, 'Act locally, think globally,' seems to have emerged in the 1970s (London Telegraph 2000), around the time of the end of the cold war, when information and communications technologies spread widely, when local and global interests started to merge. The trend to glocalisation affected citizen science, community informatics, and community archives alike.

'Glocalisation' is an ugly word which nicely encapsulates the interactions between local and global culture, and adaptations to accommodate differences between them. Whereas in business contexts, glocalisation usually begins with global activity (such as the production of international machine like a car) and ends with local expectations of its usefulness (e.g., left-hand steering), in the conservation context it begins in small local communities and radiates out in the other direction (Benking 1994). Interviewee 12 stressed that her first 'loyalties lie with the local [APSV] group and with the local area', and that as a second priority she may access databases with wider coverage only if she has time. Interviewee 3 noted a strong element of trust in the local group, and a general willingness to share knowledge. He enjoyed the camaraderie:

The main benefits are at the district level, because that's where everything happens. ... All the things that the groups do, they're great. If you buy a plant from a nursery and stick it in your garden, and you get an opportunity to see it in remnant vegetation in the wild as it has been for millions of years there, it's just fabulous. The field trips are really important.

With this level of esprit de corps it is hardly surprising that attitude and action are focused on the immediate area.

Citizen scientists are bounded in activity, if global in awareness. It may be that the mainstream scientists are more preoccupied with 'the ability to view local benefits within the broader contexts of interconnectedness, cumulative impacts, and scale' (Triezenberg, Knuth, and Dickinson 2012 p. 214). Although groups operate in 'little boxes' locally, at the same time they are capable of participating in collective action and social networks, which operate hand-in-hand, as scholars of community informatics are aware. Wellman and Hampton point out that online communities allow for 'far-flung kinship, workplace, interest group, and neighbourhood ties. … Paradoxically, computer networks encourage the formation and strengthening of local relationships' (Wellman and Hampton 1999 p. 649, 651).

The co-existence of local solidarity and unbounded network interactivity is common in most wired communities, which are characterised by 'collaborative specialization, information dispersal and multiple or distributed ownership [of knowledge resources, and] decentralized and horizontal support structures' (Gurstein 2007 p. 68). Such is the experience of the APSV participants. Interviewee 11 set up her own plant website so that other conservationists worldwide could find her large collection of photographs via search engines. Local communities of conservationists were among the earliest to appreciate the power of computer networks and to partner in resource-sharing 'in the post-custodial archival world' (Gilliland-Swetland 1996 p. 58). To capitalise on the local-national relationship, in the UK the government and non-government organisations have funded Local Record Centres as a means to collect, manage and share wildlife data online, and to assist with centralised monitoring and planning (Lawrence and Turnhout 2005).

Conclusions and ways forward

To conclude, this paper has identified four topics which emerged from an ethnographic study of the Australian Plants Society Victoria, based on interviews in 2011, and followed by a survey in 2013. The study of this environmental voluntary group – typical of millions of such groups around the globe -- is ongoing. The four emergent topics were: a lack of expertise on the part of APSV members in the use of information and communications technology; concerns about plant data quality; the relationship of citizen science to mainstream science; and the differences and similarities between local and global communities of interest. It is argued that the four topics are relevant to the central tenets of the disciplines of community informatics and community archives.

APSV volunteers can be called 'citizen scientists' for several reasons, not least because they have been committed to supporting local conservation with fieldwork data for decades. We found that volunteers were very keen to share their conservation values, a sense of belonging, and face-to-face interaction with enthusiasts rather than relying on virtual contact. Connecting with other like-minded conservation organisations was common. Typically volunteers gathered together to collect data (primarily photographs) in the field, using mobile technologies and online sources for identification occasionally, but relying more heavily on their own memories and mutual experiences, and collections of print sources of knowledge. Often their own peers had written their source books and/or articles.

These citizen scientists created local archives of plant specimens for propagating or recordkeeping. Although members were aware of the potential of information and communications technologies for data collecting and management, there was a tendency for them to keep their collected records on their own databases at home, just to share them locally, and not to upload them to large digital repositories, such as NatureShare, which most knew about at the time (in 2011). Volunteers found it hard to transfer their knowledge and enthusiasm to online systems at the time, partly because of their older age and lack of experience and understanding of technologies, and partly because of the absence of systematic training within the APSV. In other countries it is clear that proper know-how about information technology builds community spirit and improve the effectiveness of environmental organisations. Equally, in a virtuous circle, training and leadership results in increased usage of information and communications technologies.

Regarding quality of data, inaccuracy of collected data can be prevented by judicious cross-referencing, deploying expert advice and comprehensive metadata, and provision of open access to authoritative sources (such as official herbaria). In various trials, citizen scientists have been found to collect data as reliably as professional scientists. Once local data were merged with other data in large digital repositories, there was a genuine fear on the part of local volunteers of loss of control and misuse of their data by remote others.

A small percentage of APSV volunteers uploaded their data to large repositories. Obstacles which prevented the free flow of information were the experience of neglect by citizen scientists of their special contributions and lack of ultimate attribution by repositories of their valued work. Many citizen scientists in the APSV were retired professionals with tertiary degrees, familiar with the scientific turn of mind. There was no rightful place for condescension by mainstream scientists.

Acting locally and thinking globally in a conservation mode were well understood by participants. Yet the local scene remained most important to them because their familiar peers functioned close by and joint plant knowledge was locally-generated. Global connections, orchestrated on computer networks, were yet to attract the commitment of APSV members on a wide scale, although the infrastructure has existed for years.

To respond to some of these findings, the next phase of this study aims to:

- continue to embed processes for the promotion of environmental sustainability as part of community-building strategies;
- continue to draw further on the expertise, advice and support of like-minded key partner communities, at national, state and local levels;
- facilitate the training of volunteers in more effective ways to manage data and archives from the point of creation to their inclusion in major repositories; and
- focus on these objectives by means of a collaborative ‘ground up’ approach, as opposed to any ‘top down’ process (Institute of Museum and Library Services 2012).

Next the research team is developing a training program to improve the computer literacy of APSV participants, and to develop more systematic instruction by training trainers. The second phase will be reported in a separate paper later.

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