NOTICE OF MEETING

BIODIVERSITY ADVISORY COMMITTEE MEETING

An Biodiversity Advisory Committee Meeting of Byron Shire Council will be held as follows:

Venue	**Conference Room, Station Street, Mullumbimby**
Date	**Monday, 15 October 2018**
Time	**3:15pm**

Shannon Burt
Director Sustainable Environment and Economy

I2018/1947
Distributed 08/10/18

CONFLICT OF INTERESTS

What is a "Conflict of Interests" - A conflict of interests can be of two types:

Pecuniary - an interest that a person has in a matter because of a reasonable likelihood or expectation of appreciable financial gain or loss to the person or another person with whom the person is associated.

Non-pecuniary – a private or personal interest that a Council official has that does not amount to a pecuniary interest as defined in the Local Government Act (eg. A friendship, membership of an association, society or trade union or involvement or interest in an activity and may include an interest of a financial nature).

Remoteness – a person does not have a pecuniary interest in a matter if the interest is so remote or insignificant that it could not reasonably be regarded as likely to influence any decision the person might make in relation to a matter or if the interest is of a kind specified in Section 448 of the Local Government Act.

Who has a Pecuniary Interest? - a person has a pecuniary interest in a matter if the pecuniary interest is the interest of the person, or another person with whom the person is associated (see below).

Relatives, Partners - a person is taken to have a pecuniary interest in a matter if:

- The person's spouse or de facto partner or a relative of the person has a pecuniary interest in the matter, or
- The person, or a nominee, partners or employer of the person, is a member of a company or other body that has a pecuniary interest in the matter.

N.B. "Relative", in relation to a person means any of the following:

(a) the parent, grandparent, brother, sister, uncle, aunt, nephew, niece, lineal descends or adopted child of the person or of the person's spouse;

(b) the spouse or de facto partners of the person or of a person referred to in paragraph (a)

No Interest in the Matter - however, a person is not taken to have a pecuniary interest in a matter:

- If the person is unaware of the relevant pecuniary interest of the spouse, de facto partner, relative or company or other body, or
- Just because the person is a member of, or is employed by, the Council.
- Just because the person is a member of, or a delegate of the Council to, a company or other body that has a pecuniary interest in the matter provided that the person has no beneficial interest in any shares of the company or body.

Disclosure and participation in meetings

- A Councillor or a member of a Council Committee who has a pecuniary interest in any matter with which the Council is concerned and who is present at a meeting of the Council or Committee at which the matter is being considered must disclose the nature of the interest to the meeting as soon as practicable.
- The Councillor or member must not be present at, or in sight of, the meeting of the Council or Committee:
  (a) at any time during which the matter is being considered or discussed by the Council or Committee, or
  (b) at any time during which the Council or Committee is voting on any question in relation to the matter.

No Knowledge - a person does not breach this Clause if the person did not know and could not reasonably be expected to have known that the matter under consideration at the meeting was a matter in which he or she had a pecuniary interest.

Participation in Meetings Despite Pecuniary Interest (S 452 Act)

A Councillor is not prevented from taking part in the consideration or discussion of, or from voting on, any of the matters/questions detailed in Section 452 of the Local Government Act.

Non-pecuniary Interests - Must be disclosed in meetings.

There are a broad range of options available for managing conflicts & the option chosen will depend on an assessment of the circumstances of the matter, the nature of the interest and the significance of the issue being dealt with. Non-pecuniary conflicts of interests must be dealt with in at least one of the following ways:

- It may be appropriate that no action be taken where the potential for conflict is minimal. However, Councillors should consider providing an explanation of why they consider a conflict does not exist.
- Limit involvement if practical (eg. Participate in discussion but not in decision making or vice-versa). Care needs to be taken when exercising this option.
- Remove the source of the conflict (eg. Relinquishing or divesting the personal interest that creates the conflict)
- Have no involvement by absenting yourself from and not taking part in any debate or voting on the issue as if the provisions in S451 of the Local Government Act apply (particularly if you have a significant non-pecuniary interest)

RECORDING OF VOTING ON PLANNING MATTERS

Clause 375A of the Local Government Act 1993 – Recording of voting on planning matters

(1) In this section, **planning decision** means a decision made in the exercise of a function of a council under the Environmental Planning and Assessment Act 1979:
  (a) including a decision relating to a development application, an environmental planning instrument, a development control plan or a development contribution plan under that Act, but
  (b) not including the making of an order under Division 2A of Part 6 of that Act.

(2) The general manager is required to keep a register containing, for each planning decision made at a meeting of the council or a council committee, the names of the councillors who supported the decision and the names of any councillors who opposed (or are taken to have opposed) the decision.

(3) For the purpose of maintaining the register, a division is required to be called whenever a motion for a planning decision is put at a meeting of the council or a council committee.

(4) Each decision recorded in the register is to be described in the register or identified in a manner that enables the description to be obtained from another publicly available document, and is to include the information required by the regulations.

(5) This section extends to a meeting that is closed to the public.

BUSINESS OF MEETING

1. APOLOGIES

2. DECLARATIONS OF INTEREST – PECUNIARY AND NON-PECUNIARY

3. ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

3.1 Biodiversity Advisory Committee Meeting held on 14 June 2018

4. STAFF REPORTS

Sustainable Environment and Economy

Infrastructure Services

STAFF REPORTS - SUSTAINABLE ENVIRONMENT AND ECONOMY

Report No. 4.1 **Broken Head Reserve and Seven Mile Beach Road**
Directorate: Sustainable Environment and Economy
Report Author: Sharyn French, Manager Environmental and Economic Planning
Evan Elford, Team Leader Infrastructure Planning
File No: I2018/1734
Theme: Sustainable Environment and Economy
Planning Policy and Natural Environment

Summary:

Council at the 23 August 2018 meeting considered a report on recent and future actions regarding ongoing issues associated with traffic and parking management at Broken Head Road and Seven Mile Beach.

A request was received from a Committee member to provide further information on the effects of silt running from the Seven Mile Beach Road into the Broken Head Nature Reserve, and the associated dust from the road affecting the native flora and fauna in dry times.

The view of the Committee member is that Broken Head Nature Reserve and private properties in Broken Head have one of Australia's highest recognised levels of native biodiversity, yet for years the silt and dust from Seven Mile Beach Road has, and continues to run into the Reserve and onto private properties as a pollutant.

RECOMMENDATION:

That the Biodiversity and Advisory Committee note this report.

Report

Council at the 23 August 2018 meeting considered a report on recent and future actions regarding ongoing issues associated with traffic and parking management at Broken Head Road and Seven Mile Beach.

Council resolved:

Resolution 18-554

1. Note the work and stakeholder commitment to date on the issues and endorse the future actions and investigations for Broken Head Reserve, Seven Mile Beach Road and Broken Head Reserve Road

2. Provide a report providing information on the following;

a. An investigation, design and cost assessment of parking and traffic management on Broken Head Reserve Road with a view to utilise any funds raised to fund fully sealing Seven Mile Beach Road.

b. The car parking management option of establishing a ticketing system at the entrance to Seven Mile Beach Road

c. The creation of a shared road sealed road that commences at Seven Mile Beach Rd and Reserve Rd intersection and continues until King's Beach Carpark.

d. The development of a locality plan for Broken Head Reserve Road from Broken Head Road to the intersection with Seven Mile Beach Road, that addresses

i. Key ecological, safety and compliance issues
ii. A draft budget and the availability of S94 funding
iii. The establishment of a working group and identification of key stakeholders, including the Arakwal Corporation and state government agencies

A committee member request was received to provide further information on the effects of silt running from the Seven Mile Beach Road into the Broken Head Nature Reserve, and the associated dust from the road affecting the native flora and fauna in dry times.

Council has approximately 100km of unsealed gravel roads throughout our LGA.

Gravel roads will generate dust and water borne silt through the effects of natural weather erosive forces (wind and rain) and also by the effects from traffic.

The only definitive method to minimise the dust and silt impacts of an unsealed gravel road are to construct and seal the road pavement and ensure full vegetation cover on the road shoulders. This will minimise, not stop, these impacts as there is still runoff from a sealed road, through pavement defects, roadside table drains and the like.

As advised in the attachment to the report to Council on 23 August 2018, the estimated costs to construct and fully seal Seven Mile Beach Road are in the range of $3 to $4.4M. This would need to be further refined by the allocation of funding by Council to investigate and design the road construction works, through concept and detailed designs.

There have been no specific studies by Council in the recent past on any impacts on the vegetation adjoining the unsealed road pavement of Seven Mile Beach Road. Again the allocation of a budget by Council would be required to undertake such a study.

Financial Implications

Nil

5

Statutory and Policy Compliance Implications

Nil

Report No. 4.2 **Brunswick Valley Landcare - Landcare Support Officer Report**
Directorate: Sustainable Environment and Economy
Report Author: Sharyn French, Manager Environmental and Economic Planning
File No: I2018/1748
Theme: Sustainable Environment and Economy
Planning Policy and Natural Environment

Summary:

The Biodiversity Advisory Committee considered a report at the 12 March 2018 meeting on the services that Brunswick Valley Landcare provide to Council and the community and the changes to grant funding that enables these services.

The Committee recommended that Council consider an allocation of funds in the 2018/19 budget to support the Brunswick Valley Landcare, Landcare Support Officer position for 1 day per week to continue to deliver the Land for Wildlife Program and respond to customer enquiries.

Funds were subsequently allocated in the 2018/19 budget.

This report tables the activities of the Landcare Support Officer for the July to September period.

RECOMMENDATION:

That the Biodiversity Advisory Committee notes the report.

Attachments:

1 Landcare Support Officer report September 2018, E2018/75604 , page 9

Report

The Biodiversity Advisory Committee considered a report at the 12 March 2018 meeting on the services that Brunswick Valley Landcare provide to Council and the community and the changes to grant funding that enables these services.

The Committee recommended that Council consider an allocation of funds in the 2018/19 budget to support the Brunswick Valley Landcare, Landcare Support Officer position for 1 day per week to continue to deliver the Land for Wildlife Program and respond to customer enquiries.

Council supported this funding and attached is the report from the Landcare Support Officer for the Committees reference.

Financial Implications

Funding allocated in 2018/19 budget.

Statutory and Policy Compliance Implications

Nil

Landcare Support Officer Report for Byron Shire Council

1st July – 10th September 2018

LFW

- Sent out a letter to 65 properties who registered with Council for LfW to ask for their updated contact details.
- Site visits on 25/6/2018 for
  - Heartmut Nauss
  - Tom Lane, The Farm
- Site visits on 30/8/2018 for
  - Fitzsimons, Martin x 2 properties, one at Coopers Lane West, Main Arm and one at Billinudgel Road, Billinudgel.
- Registrations completed
  - Sue Hainining
  - Heartmut Nauss
  - Tom Lane, The Farm
  - Wayne Lynch
  - Fitzsimons, Martin x 2
  - Sharp, Deb
- Met with John Asquith from Community Environment Network (CEN) provider of Land for Wildlife in NSW on 9th August. Update on where the program stands with regards to funding from the Environmental Trust and how Land for Wildlife fits with the new conservation agreements that BCT are offering.

COUNCIL

- Met with Rachel the GIS officer at council on Thursday 12/7/2018 and learnt how to add all the locality groups onto GIS. Am slowly mapping the locations of all BVL's locality groups and all the other Landcare groups in the shire so a layer can be added to Geocortex.
- Met 12 year 12 students from Byron Bay High School onsite in Baywood Chase swamp with David Filipczyk to talk to them about invasive species.
- Circulated updated list of Landcare and Dunecare groups to council staff.
- Liaised with Kate Ackerman about reworking my Green Waste dumping flyer into a pamphlet for use by council.
- NLP Environmental Small Grant was successful for Yallakool Reserve in Ocean Shores for track work, regen, planting, signage, and community education days - $49, 816 excl GST.
- Attended training on using the new technology in the conference room, 13th August.
- Co-presented a training session with Jo Green on the new Native Species Planting Guide for council staff 16th August.

- Worked with Sandy Pimm to deliver Private Land Conservation workshop on 31st August. Speakers from the Biodiversity Conservation Trust. Landcare took bookings and provided and morning tea. 24 attendees, great feedback from all participants. Copies of the powerpoint presentations of both Mark and Georgia are available – sent to 6 people.
- Worked with Jo Green and John Turnbull from TSC to deliver Native Species Planting Guide workshop on 24th August – 24 attendees, good feedback on the online resource and about 15 people came to Heritage Park for the planting demo – which went well. Landcare took bookings and provided and morning tea.

10 September 2018 *Report by Alison Ratcliffe*

ENQUIRY TOPICS/ ISSUES

Phone	Email	Walk in
BVL membership	Funding – BCT	Weed ID
Byron Scouts – Landcare Australia events for Landcare badge	Mapping for property planning	
Landholder looking for funding	Regen contractors	
Bush regen contacts	Volunteer opportunities	
Bush regen contacts	Maps	
Locality group info	Contact details	
Volunteering opps in Mullum	Funding – SOS	
Funding from BCT	Funding – BCT	
Volunteer Opportunities	Funding – BCT	
Volunteer Opportunities	Land for Wildlife	
Tree guards and stakes for re-use	MLNG and weed books	
	Support for Bangalow Landcare	
	Insurance	
	local school – wanting to create a bush food garden	
	Mapping	
	local pre school wanting to create a bush food garden and connect with local indigenous leaders	
	Planting out creeks and dams	
	Starting a new Landcare group	
	Contacts	
	Planting list	
	mapping	
	Salvinia weevels	
	Collaboration on projects - Renew Fest	
	Collaboration on projects - Flo Gardens	
	Collaboration on projects - Earn and Return	
	Collaboration on projects - Federal Park Party	
11	**26**	**1**

10 September 2018 *Report by Alison Ratcliffe*

Report No. 4.3 **Coastal and Biodiversity Projects Update**
Directorate: Sustainable Environment and Economy
Report Author: Sharyn French, Manager Environmental and Economic Planning
File No: I2018/1756
Theme: Sustainable Environment and Economy
Planning Policy and Natural Environment

Summary:

This report provides a short update on the key coastal and biodiversity projects. The Project Manager for each project will provide further updates at the meeting to inform Committee discussion.

RECOMMENDATION:

That the Biodiversity Advisory Committee notes the report.

Attachments:

1 Brown et al 2018 Assessing the validity of crowdsourced wildlife observations ACCEPTED, E2018/76195 , page 15⇩

Report

Coastal Key projects

Coastal Management Program (Stage 1) Scoping Studies
Council has been successful in receiving grant funding from OEH to assist in the development of a Scoping Study. The Study is the first stage in preparing a Coastal Management Program for two locations:

- The Northern Shire Beaches comprising Brunswick Heads Beach, New Brighton Beach and South Golden Beach, excluding the Brunswick Estuary (*the Brunswick River/Estuary will be considered in the future on a priority basis and as resources permit*).
- The Byron Bay Embayment including the beaches from Cape Byron to Tyagarah, including the Belongil Estuary.

The Scoping Study will be completed in accordnace with the new coastal legislation, the *Coastal Management Act 2016* and the NSW Coastal Manual. In this first stage issues and opportunties will be identified along with assessment of the adequacy of the current management arrangements for the project locations. This will include a review of priorities, triggers for change and current and planned actions. The project kicks off at the end of September 2018 and will involve Councillor and community consultation throughout delivery.

Belongil Estuary Entrance Opening Strategy
This project is primarily delivered by the Infrastructure Services team as the Belongil Estuary entrance (mouth of the creek) is opened for flood mitigation purpose. However outcomes of the project will directly influence the development of a Coastal Management Program for the Byron Bay Embayment and preparation of the Scoping Study (as outlined above).

Council has been opening the Belongil Estuary for approximately 60 years and formalisation of a sustainable long-term Entrance Opening Strategy will determine key responsibilities for management of the entrance in close consultation with the community and public agencies. One of the primary objectives of the Strategy is to minimise interference with natural entrance opening processes and minimise impacts on ecological processes and communities. Council has engaged a consultant for this large project with the initial Findings report due to be presented to the Coastal and Estuary Catchment Panel at the end of September.

Biodiversity Key Projects

Integrated Pest Management Strategy and Policy
Council adopted the Integrated Pest Management Policy (IPM) at the 23 August meeeting. The Policy will guide the development of a IPM Strategy which will provide a practical framework that aligns with both Council's statutory obligations and community needs. Work on the draft Strategy has commenced. A Research Officer has been engaged to support development of the Strategy.

The Strategy will carefully consider all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimise risks to human health and the environment

The Strategy will establish local priorities for pest species and areas to be managed and will include an action plan outlining timeframes and responsibility for implementation. It is intended to inform, consult and involve community in this process.

Pest Animal Management Plan
Council's draft Pest Animal Management Plan finished being publicly exhibited on the 21 September. Our draft Plan has been prepared in accordance with the NSW Biosecurity Act 2015

and Local Land Services Act 2013 and consultation with the community, to manage pest animals in our Shire

The Plan looks at the problem of pest animals and ways to address and manage their impacts primarily on Council-managed land particularly in the areas of prevention, eradication, containment and asset protection.

Meanwhile, Council has engaged a professional private trapper to target wild dogs, foxes and feral cats on Council managed land.

Biodiversity Conservation Strategy
The staged review of the Plan continues with recent farmers meeting held in Huonbrook on 5 September. This meeting was designed to better understand the needs of our farmers in caring for country and how Counciil can support them.

A draft Strategy is expected to be exhibited in early 2019.

Koala Plan of Management
Council's draft KPOM has been with the Department of Planning and Environment since 2016. Their approval has been held up pending the SEPP 44 review.

Irrespective of the state governments endorsement of the plan, actions are being implemented via five current projects and partner projects, including:

- Implement a Dog's Breakfast event to encourage responsible domestic dog ownership in areas of koala habitat
- Continue working with 5 landowners to restore and enhance koala habitat
- Undertake 250hrs of bush regeneration in areas of remnant vegetation to existing koala habitat
- Conduct a workshop to educate and raise awareness of koala and threatened species issues
- Assist in the development of regional scale actvities to promote koala conservation

Additionally, and through the North Coast Koala Linkage Project Council staff have susscussful co-authored two scientific papers from this research focused work in the journal of Biological Conservation, a leading international journal in the discipline of conservation science. This first published paper, assesses the validity of crowdsourced wildlife observations for conservation using public participatory mapping methods (**Attachment 1** E2018/76195) October 2018). Highlights

- Evaluates validity of crowdsourced observation data for wildlife conservation (koala)
- Compared accuracy of citizen observations against authoritative koala distribution model
- Analysed citizen characteristics as predictors of koala observation accuracy
- Found significant spatial association between citizen observations and koala model
- Participant knowledge of koalas, age, length of residence, and formal education were related to observation accuracy

The second paper, to be published later in 2018, explores the integration of social spatial data to assess wildlife conservation opportunities and priorities. Highlights

- A novel, socio-ecological approach for identifying conservation opportunity that spatially connects landscapes with community preferences to prioritise investment in koala recovery and monitoring strategies at a regional scale
- Important research questions regarding the design, collection, and analysis of crowdsourced mapping data and its utility for identifying socially acceptable conservation opportunities were addressed

- Found ecological, social, and economic criteria included in the conservation assessment, contributed different information with the social acceptability criterion exerting the greatest influence on spatial conservation priorities.
- The systematic assessment of social criteria for conservation using spatial surveys provides information that can be integrated with ecological and economic information to prioritize conservation opportunities across a range of land uses and tenure

Flying Fox Camp Management

Implementation of the Byron Shire Flying-fox Camp Management Plan has commenced. Actions include:

- Undertake quarterly flying-foxes surveys as part of the National Flying-fox Monitoring Program
- Appointed a Project Support Officer
- Establish and implement a Project Reference Group
- Undertake community engagement activities
- Been awarded a grant of $79,050 under the 2018 round of the Restoration and Rehabilitation program. This grant is for the delivery of the project entitled *Flying Improvement – working towards flying-fox and community coexistence,* due to commence later in 2018.

Byron Bay Dwarf Graminoid Clay Heath

Over the last decade, Council funds, together with State Government and private contributions have enabled the restoration work. Actions in 2018-19FY are being implemented via the Clay Heath Management Plan and include

- Improving community updates on our restoration activities
- Undertaking 1-3-6-month post burn weed control at Paterson Hill East Water Tower site and installing educational signage and fencing.
- Follow up weed management and tree removal across all sites on Council-managed land.

Disappointingly, Council were not successful on its grant application under the Public Reserves Management Fund Program under which Council submitted a funding application to the value of $10, 000 for continued restoration activities.

Financial Implications

Nil

Statutory and Policy Compliance Implications

Nil

Biological Conservation 227 (2018) 141–151

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Assessing the validity of crowdsourced wildlife observations for conservation using public participatory mapping methods

Greg Brown[a,b,*], Clive McAlpine[c,d], Jonathan Rhodes[c], Daniel Lunney[d,e], Ross Goldingay[f], Kelly Fielding[g], Scott Hetherington[h], Marama Hopkins[h], Clare Manning[i], Mathew Wood[j], Angie Brace[k], Lorraine Vass[l]

[a] California Polytechnic State University, San Luis Obispo, CA 93401, United States of America
[b] School of Earth and Environmental Sciences, University of Queensland, Brisbane, Australia
[c] School of Earth and Environmental Sciences, University of Queensland, Brisbane 4072, Australia
[d] School of Life and Environmental Sciences, University of Sydney, NSW 2006, Australia
[e] Office of Environment and Heritage, NSW 2220, Australia
[f] School of Environment, Science and Engineering, Southern Cross University, Lismore, Australia
[g] School of Communication and Arts, University of Queensland, Brisbane 4072, Australia
[h] Tweed Shire Council, Murwillumbah, NSW 2484, Australia
[i] Byron Shire Council, Mullumbimby, NSW 2482, Australia
[j] Ballina Shire Council, Ballina, NSW 2478, Australia
[k] Lismore City Council, Lismore, NSW 2480, Australia
[l] Friends of the Koala, Lismore, NSW 2480, Australia

ARTICLE INFO

Keywords:
Koala
Citizen science
PPGIS
VGI
Wildlife observation
Public participation

ABSTRACT

Public participatory mapping is a method of crowdsourcing where the lay public can contribute spatial information for a range of applications including conservation planning. When used to collect wildlife observation data, participatory mapping becomes a type of "geographic citizen science" that involves collaboration with members of the public. While the potential of crowdsourcing to assist in wildlife conservation appears to be large, the quality and validity of the observational data collected remain a key concern. In this study, we examined the quality and validity of spatial data collected in a public participatory mapping project implemented in northern New South Wales (Australia) in 2018 where the public was asked to identify and map the location and frequency of koala (*Phascolarctos cinereus*) sightings using an internet mapping application. The iconic koala is a nationally-listed threatened species and has wide public recognition, making it an ideal test of our approach to examining the value of citizen science for wildlife. We assessed the validity of koala observation data from two perspectives of *validity-as-accuracy* (positional accuracy and data completeness) and *validity-as-credibility* (characteristics of spatial data contributors). To assess *validity-as-accuracy*, we analysed the distribution of citizen observations of koala sightings compared to an expert-derived probability distribution of koalas (likelihood model). To assess *validity-as-credibility*, we analysed the survey data to determine which participant characteristics increased the credibility of observational data. We found significant spatial association between crowdsourced koala observations and the likelihood model to validate koala locations, but there was under-reporting in more rural, remote areas. Significant variables contributing to accuracy in koala observations included participant knowledge of koalas, age, length of residence, and formal education. We also compared the crowdsourced results to a field-based citizen science koala observation project implemented in the same region and found crowdsourced participatory mapping provided comparable, if not superior results. Crowdsourced koala observations can augment field-based koala research by covering large geographic areas while engaging a broader public in conservation efforts. However, effective geographic citizen science projects require a significant commitment of resources, including the creation of community partnerships, to obtain high quality spatial data.

* Corresponding author.
E-mail address: ggbrown@calpoly.edu (G. Brown).

https://doi.org/10.1016/j.biocon.2018.09.016
Received 22 June 2018; Received in revised form 17 August 2018; Accepted 10 September 2018

1. Introduction

Public participatory mapping and volunteered geographic information (Goodchild, 2007) are methods of crowdsourcing (Howe, 2006) where the lay public can contribute spatial information for a range of environmental applications, including research for conservation planning. Citizen science has been defined as activities in which non-professional scientists participate in data collection, analysis and dissemination of a scientific project (Cohn, 2008). The term "geographic citizen science" refers to a subset of general citizen science where the collection of location information is an integral part of the activity (Haklay, 2013). The potential of crowdsourcing in geographic citizen science to assist in environmental problems, such as species conservation, appears large. However, the quality and validity of the citizen observation data collected remain a key concern (Alabri and Hunter, 2010; Brown et al., 2015). For example, Hunter et al. (2013) describe some of the weaknesses in general citizen science that also apply to geographic citizen science projects including the use of poorly-designed methods of data collection resulting in incomplete or inaccurate data. In participatory mapping, often called public participation GIS (PPGIS), and volunteered geographic information (VGI), a solid framework for assessing the quality of crowdsourced spatial data has yet to be established given these methods are fundamentally different to traditional geospatial assessment. The difference is due to social factors driving public contribution and the variety of types and sources of spatial content (Antoniou and Skopeliti, 2015). Furthermore, comparable authoritative data may not be available for assessing and evaluating citizen contributed data, thus requiring the use of proxy data or modelling estimates of spatial distribution.

Citizen science data can be a valuable source of information on changes in species distributions and biodiversity (Schmeller et al., 2009) but data quality may be limited due to the potential for observational bias, reporting bias, and geographical bias (van Strien et al., 2013). According to Bonney et al. (2009), contributions from citizen scientists now provide a significant quantity of data about species occurrence and distribution around the world, and include well-established projects such as *eBird*, a web-enabled community of bird watchers who collect, manage, and store their observations in a globally accessible unified database (Sullivan et al., 2009). The number of citizen science projects has grown significantly with the *SciStarter* website providing a database of > 2700 searchable citizen science projects and events (https://scistarter.com/about). With the large, rapid increase in citizen science projects, there is an increasing need for research that evaluates the quality and validity of citizen data, examines the best approaches for integration of citizen and professional/specialist science, and the design of citizen science programs for their long-term sustainability and adaptability (Paul et al., 2014).

Our focus here is on identifying and elaborating methods to evaluate the quality of crowdsourced, citizen-contributed geospatial knowledge in the specific context of species location information. Given that crowdsourced spatial data include both the social processes used to collect spatial data, and the actual spatial data generated, an assessment of data quality and validity (fitness for purpose) should include both elements. To evaluate the quality of crowdsourced data, we used the two perspectives described by Spielman (2014): *validity-as-accuracy* and *validity-as-credibility*. The *validity-as-accuracy* perspective assesses the contributed spatial data against authoritative data while the *validity-as-credibility* assesses the characteristics of the data contributors such as reputation, motivation, and place familiarity that may influence spatial data quality. Van Exel et al. (2010) used the term *crowd quality* to describe these data quality perspectives. As a general concept, *crowd quality* seeks to assess the collective intelligence of crowd-generated data.

The *validity-as-accuracy* perspective examines spatial data quality using criteria applied to expert-derived spatial data such as *positional accuracy*, *attribute accuracy*, *logical consistency*, *completeness*, and *lineage* (see Federal Geographic Data Committee www.fgdc.gov/metadata/csdgm). Additional criteria for evaluating volunteered geographic information (VGI) data against authoritative data include *temporal accuracy* and *usability* (Antoniou and Skopeliti, 2015). The *validity-as-accuracy* perspective has been applied to VGI systems, such as the positional accuracy and completeness of public contributions to OpenStreetMap (OSM) (Haklay, 2010; Girres and Touya, 2010; Zielstra and Zipf, 2010). These studies indicated the positional accuracy of OSM data were comparable to geographical data maintained by national mapping agencies and commercial providers. Within the domain of conservation planning, moderately high levels of accuracy have been found from crowdsourced data in the location of native vegetation in New Zealand (Brown, 2012), in identifying habitat for threatened species conservation (Cox et al., 2014), and for mapped values in areas of high conservation importance (Brown et al., 2015).

The *validity-as-credibility* perspective in participatory mapping or VGI seeks to account for data quality based on the characteristics of citizen contributors. There have been relatively few published studies that evaluate participant-related variables of data quality for geographic citizen science data. Potential reasons for the lack of data quality assessment from a *validity-as-credibility* perspective include absence of participant-related data beyond basic demographic information, a predisposition towards finite citizen mapping projects over longer-term continuous projects that provide greater opportunity for data collection, and project emphasis on spatial information over user-related information. A consistent participant variable found to influence spatial data quality is participant familiarity and experience in the geographic study area. For example, Brown (2012) found that participant familiarity with the study area contributed to spatial accuracy in identifying native vegetation. In general, participatory familiarity with the study area contributes to greater mapping effort which can be a proxy for data quality when mapping subjective spatial attributes, such as place values, experiences, and preferences (Brown, 2017).

1.1. Citizen science and koala observations

There have been several field-based, citizen science projects in Australia with a focus on koalas (*Phascolarctos cinereus*). The koala has an advantage for citizen science projects because it is unique and no other animal looks like a koala. At 5–10 kg in size, it is easy recognizable once spotted and remains in people's memories. Sequeira et al. (2014) produced the first citizen science-generated estimates of koala habitat suitability and population size in South Australia based on a citizen observation program called the "Great Koala Count" which generated 1359 observations from over 1000 data contributors. While the spatial accuracy was high (i.e., *validity-as-accuracy*) because koala locations were logged using GPS technology, the limitations of the citizen-science collected data included a limited sampling window (one day observation) and significant geographic bias—most of koala observations were made within conservation parks, along streets, or in suburban backyards in areas proximate to Adelaide, South Australia. The citizen participants were also not representative of the entire South Australian population (Hollow et al., 2015). A second "Great Koala Count II" was conducted in South Australia in 2016 to address some of the limitations of the first project including an expanded sampling timeframe (see https://www.discoverycircle.org.au/projects/koala/) with results yet to be published.

Similar to the South Australian koala citizen-science projects, a field-based koala observation program was conducted in New South Wales (NSW) in 2013 and 2014 by the National Parks Association of New South Wales (www.npansw.org) and the Atlas of Living Australia (www.ala.org.au). This project was also called the "Great Koala Count" and the project area included the north coast of New South Wales, the geographic focus of the study reported herein. Data from the NSW "Great Koala Count" provide an opportunity to compare the results from two different citizen science methods (field-based "Great Koala

Count" and crowdsourced internet mapping conducted in the current study) against independent koala distribution models.

Predavec et al. (2018) used repeat community (citizen science) surveys in 2006 and 2015 to assess population change in koalas in northwest NSW. The surveys requested participants to identify the locations of koala sightings and eight other common species on hardcopy colour maps and markers in the 2006 survey and a Google Maps application interface using digital markers in the 2015 survey. The two community surveys had 479 and 413 responses respectively, with 813 and 619 reported koala sightings. The study found that koala numbers had declined over time across the study region. A strength of the community survey method was the ability to obtain data over a large geographic region while limitations included response bias in observations towards roads or other public spaces, with observations concentrated around urban centres.

1.2. Purpose and research questions

In this study, we examined the quality and validity of spatial data collected in a participatory mapping project implemented in the north coast region of New South Wales, (Australia) in 2018 where the public was asked to map the location and frequency of sightings of the iconic, but vulnerable koala using an internet mapping application. The independent koala species distribution information for evaluating citizen observations is a koala likelihood mapping model developed by a team of researchers for the NSW government (Predavec et al., 2014, 2015). To evaluate the quality of crowdsourced koala data from a *validity-as-accuracy* perspective, we compared the spatial locations of citizen observations with the koala likelihood map. We asked: Are citizen observations significantly correlated with higher probabilities of koalas being present? We then evaluated the quality of the crowdsourced observation data from a *validity-as-credibility* perspective by examining participant characteristics that may contribute to better predications of koala locations. In other words, what participant characteristics would be desirable to better estimate the geographic distribution of koalas? For comparison, we also evaluated the crowdsourced koala data against observation data collected from the NSW "Great Koala Count" to assess the relative strengths and weaknesses of these two citizen-based observation methods.

2. Methods

2.1. Study area

The study area was located on the far north coast of New South Wales, Australia, and consisted of four Local Government Areas (LGAs)—Ballina Shire, Bryon Shire, City of Lismore, and Tweed Shire. Population estimates (Australian Bureau of Statistics, 2016) for the four LGAs were as follows: Ballina (41,790); Byron (31,556); Lismore (43,135); and Tweed (91,371). The study area was selected because the far north coast of NSW supports nationally significant koala populations and the koala in NSW is listed as vulnerable under both State and Commonwealth laws. Further, the area was the focus of a joint Commonwealth-local government Tweed-Byron Koala Connections project, an ecosystem restoration project that sought to secure the future of wildlife populations by increasing the area, quality and connectivity of habitat.

2.2. Study design and data collection

In 2017, we developed an internet-based participatory mapping survey to assess location-specific community sentiment and willingness to positively engage in koala conservation and recovery programs. The survey used a Google® maps application programming interface (API) where participants were directed to drag and drop digital markers representing koala observations and land use preferences (e.g., residential or tourism development) within the study area. The mapping interface consisted of three "tab" panels with 11 markers related to koala observations located in panel one and eight land use preference markers located in panels two and three. In addition, there were five markers that asked participants to identify koala observations in the categories of *weekly*, *monthly*, *yearly*, and *only once*. There was also a marker to identify the location of *dead or injured* koalas. The survey also included text questions that identified participant characteristics (demographics), such as home location, age, gender, and formal education, as well as questions that asked participants about their knowledge of koalas and places in the study area, their attitudes towards koalas, perceived threats for koala survival, and support for various types of koala conservation efforts.

Study participants were recruited through five primary sources: (1) announcement and promotion of the study through local government (LGA) newsletters and websites, (2) conservation and community organizations such as "Friends of the Koala" and "Bangalow Koalas", (3) Facebook® advertisements, (4) news stories appearing in local media including newspapers and radio, and (5) friend and relative referrals from the above sources. The data collection effort began in December 2017 and extended through March 2018 (approximately 4 months).

2.3. Origin and description of the koala likelihood model

The koala likelihood model (Predavec et al., 2014) shows probable koala occurrence and non-occurrence within 5 km grid cells located in the study area derived from historical observation records of koalas and other mammals in the same grid cell. The historical records come from the Atlas of NSW Wildlife database maintained by the NSW Office of Environment and Heritage. The likelihood model also computes a confidence level in the probability value (high, medium, low) based on the number of wildlife observations. The koala likelihood analysis and map was based on a 20-year data window (1994–2014) of likely koala occurrence and non-occurrence where grid cells with a non-zero probability had at least one koala recorded within the review period. A companion analysis of the likelihood model found broad agreement between likely koala occurrence and locally derived koala habitat mapping (Scotts et al., 2014). The map was subsequently modified and updated based on recommendations from a koala expert workshop held in March 2015 (OEH, 2016) that included a test of the map against an independent koala survey method called the Spot Assessment Technique (SAT) (Phillips and Callaghan, 2011). The SAT survey uses the presence/absence of koala faecal pellets around the base of trees to measure koala activity. A comparison of the likelihood map with four SAT data sites showed a strong positive correlation between the likelihood map and koala activity such that the map provided a good index of koala occurrence (OEH, 2016). The likelihood model has since been updated with koala observation data covering the period from 1997 to 2017. There are, however, several caveats associated with the likelihood model: (1) data in the model come from the Atlas of NSW Wildlife where over 20% of the koala records were derived from a 2006 community survey (Lunney et al., 2009), and (2) the model does not account for local and recent koala population declines (Predavec et al., 2014).

2.4. Analyses

2.4.1. Participant characteristics (geographic and demographic)

We assessed the geographic representativeness of participants by comparing the proportion of participants within each local government area to the expected distribution and by plotting home locations in the study region area to compare with population density mapping based on the 2016 Australian census. We used descriptive statistics to analyse participant characteristics on socio-demographic variables included in the survey. We then compared demographic variable responses (age, gender, education) to population data from 2016 census data for the study area.

2.4.2. Assessing observational accuracy

The spatial data from the survey were prepared for analysis using ArcGIS® v10.4. The koala likelihood grid was clipped to the study area boundary. Full or partial 5 km grid cells within or intersecting the study boundary with likelihood data were retained for analysis resulting in 173 grid cells for analysis. Koala observations were clipped to the study area boundary, with a 3 km tolerance to capture observations in grid cells that partially intersected the study area. The frequency counts of observations for the categories of *weekly*, *monthly*, *yearly*, *once*, and *dead/injured* were tabulated for each grid cell. Observation accuracy was assessed using multiple statistical measures of association between koala observations and the likelihood model as follows:

(1) Spearman's rank correlation coefficients were calculated between the grid cell observation counts and the cell probability value from the likelihood model for each observation category and for the sum of all observation categories. To determine if observation accuracy differed by observation category (e.g., *weekly* vs. *monthly*), we calculated mean cell probability values and used analysis of variance (ANOVA) with Tukey HSD post-hoc tests to identify significant differences.
(2) Presence/absence analysis. Cross-tabulations were generated between the likelihood map and crowdsourced citizen observations where each grid cell was coded based on the presence (1) or absence (0) of one or more koala observations in each cell. This analysis assesses the consistency (spatial concurrence) between citizen observations and historical koala records to indicate whether citizens are likely to over- or under-report the presence of koalas compared to historical records. The phi-coefficient (φ) provides an overall measure of association between presence and absence cells and falls within the range of +1.0 and −1.0 with stronger relationships found at either extreme. Fitz-Gibbon and Morris (1987) suggest the following interpretation: $\varphi < 0.2$—little or no association, $0.2 < \varphi < 0.4$—weak association, $0.4 < \varphi < 0.6$—moderate association, and $\varphi > 0.6$—strong association. For comparison, we also conducted presence/absence analysis with observational data from the NSW "Great Koala Count" (GKC), a field-based citizen science project conducted in 2013 and 2014. GKC participants were requested to register as a citizen scientist and download a smartphone application to record koala sightings within specified time windows. A report on the project was prepared by Cleary (n.d.) and observational data from the GKC are available at https://collections.ala.org.au/public/show/dr799. There were 941 GKC observation records within the study area used in our analysis.
(3) To identify potential measures of spatial association, we calculated bivariate spatial autocorrelation (Bivariate Moran's I) between the summed koala observations and cell probability for each cell using GeoDa® software. The Bivariate Moran's I statistic measures *global* spatial autocorrelation, or the extent to which two different variables cluster (or not) in space based on the *proximity* of high and low grid cell values in the study area. Possible values for Bivariate Moran's I range between −1 and +1 with 0 implying no spatial autocorrelation. Positive values indicate spatial clustering and negative values indicate spatial dispersion. One would expect a positive Moran's I value if participants mapped more koala observations proximate to high koala probability values (high/high) or mapped fewer observations proximate to low probability cells (low/low). Of greater interest is the bivariate *local* indicator of spatial autocorrelation or BiLISA (Bivariate Local Indicator of Spatial Association). Rather than measuring autocorrelation across the whole study region (global), BiLISA looks for significant spatial autocorrelation locally, i.e., for each grid cell. BiLISA maps show which grid cells are statistically significant with high/high and low/low values ("I'm similar to my neighbours") or high/low and low/high values ("I'm different from my neighbours"). Thus, BiLISA maps show local areas within the larger study area where koala probabilities are similar to, or different from, koala observations.

2.4.3. Assessing participant variables contributing to accuracy

To evaluate the *accuracy-as-credibility* perspective, we examined participant variables that may be significantly related to higher cell probability values in the koala likelihood model. The cell probability value was linked to each observation based on its grid cell location. All possible linear regression models were evaluated using the (SPSS® v.25) "Best Subsets" procedure that uses the Akaike Information Criterion (Akaike, 1974) to compare and rank multiple competing models and to estimate which model best approximates the "true" underlying process. The Akaike Information Criterion (AIC) is grounded in information theory and provides an estimate of the relative rank of multiple models based on the trade-off between goodness of fit and the parsimony of the model. The procedure also quantifies model selection uncertainty in cases where no single model stands out as being the best model. By default, the SPSS subsets procedure uses *corrected* AIC which adjusts for small sample sizes.

The regression subsets procedure was run for each observation category (*weekly*, *monthly*, *yearly*, *once*, and *dead/injured*) and for *all observations combined*. The linear regression models included the following participant variables: *age*, *gender*, *education* (1 = less than bachelors, 2 = bachelors/postgraduate), *length of residence in study area*, *familiarity with study area* (1 = poor to 5 = excellent), *knowledge of koalas* (1 = no knowledge to 5 = very high knowledge), *number of observation markers*, and *distance from participant home location to the koala observation*. The model with the lowest AIC was compared to other models using the change in Akaike Information Criterion (ΔAIC) and Akaike weights to assess the uncertainty in selecting the best model. The Akaike weight has a value between 0 and 1 and can be considered the probability that a given model is the best approximating model. Higher weights indicate greater model certainty. Models with ΔAIC values less than two are considered to be as good as the best model (Richards, 2005).

After quantifying the uncertainty associated with the best model for each observation category, we ran the regression model with the predictor variables to generate the goodness of fit statistic (R-squared) and standard beta-coefficients to identify the strongest predictor variables. For each regression model, collinearity diagnostics were run to evaluate multicollinearity or the presence of highly correlated predictor variables. For all regression models evaluated, the variance inflation factors (VIF) were well below four indicating that multicollinearity was not a problem.

3. Results

3.1. Participant characteristics

There were 454 participants who mapped one or more locations in the study area and 397 participants that completed the survey questions. A profile of participants is presented in Table 1. The mean number of koala observations was four per participant, with a total of 1695 koala observations mapped in the study area. Only 2% of participants ($n = 7$) were not residents in the study area. Residents lived in the study area for an average of 20 years.

Participants were 70% female, averaged 53 years of age, and had a high level of formal education, with 65% having a bachelor's degree or higher. Compared to Australia Bureau of Statistics population statistics, study participants were older, contained proportionately more females, and had a significantly higher level of formal education. The sampling bias on age and formal education is consistent with many participatory mapping studies, but inconsistent in that participation is most often skewed towards greater male participation (Brown and Kyttä, 2014).

Participants were asked to self-rate their knowledge of koalas as well as their familiarity with places in the study area. About 58% of participants rated their familiarity with the study area as "excellent" or "good" while only 2% rated their familiarity as "poor". With respect to knowledge of koalas, about 16% rated their knowledge as "very high"

Table 1
Participant profile based on survey responses in the study area. Selected census demographics from the 2016 ABS Census are provided for comparison. Not all percentages total 100% due to rounding.

Mapping behavior	
Number of participants (mapped one or more locations)	454
Number completing post-mapping text survey	397
Number of locations mapped	6362
Range of all markers	1–366
Range of observation-only markers	0–173
Mean (median) all markers mapped	15 (7)
Mean (median) observation only markers mapped	4 (2)
Knowledge of study area	
Excellent	14%
Good	44%
Average	33%
Below average	7%
Poor	2%
Knowledge of koalas	
Very high knowledge	3%
High knowledge	13%
Moderate knowledge	49%
A little knowledge	32%
No knowledge	3%
Resident of study area	
Yes	98%
No	2%
Years lived in study area (mean, median)	20, 18.5
Participant distribution by Local Government Area (percent)	
Ballina (percent of study area population = 20%)	8%
Byron (percent of study area population = 15%)	24%
Lismore (percent of study area population = 21%)	35%
Tweed (percent of study area population = 44%)	33%
Demographics	
Gender (ABS for NSW 2016: Male 49.3%)	
Female (%)	70
Male (%)	30
Age in years (mean/median) (ABS for NSW 2016: mean 48, median 47)[a]	52/53
Education (%) (ABS for NSW 2016: 23.4% Bachelors/postgraduate)	
Less than bachelors	35%
Bachelor's degree/postgraduate	65%

[a] Estimates from 2016 grouped census data for individuals aged 20 or older.

or "high" while about half of participants rated their knowledge as "moderate".

In terms of geographic representation, participants were proportionately over-represented in the Local Government Areas (LGAs) of Byron and Lismore and under-represented in Ballina and Tweed Shires. For example, Lismore has about 21% of the study area population but accounted for 35% of the participants while Ballina has about 20% of the study area population but accounted for only 8% of participants. The geographic distribution of participants based on home location was consistent with population density in the study area (Fig. 1a) with higher concentrations of participants clustered near the population centres of Lismore, Tweeds Head, Pottsville, and Murwillumbah, with other participants widely dispersed in areas of lower population density. The number of unique participants reporting koala observations by grid cell was not systematically related to participant home location (Fig. 1b). For example, grids cells near Lismore and Pottsville had both large numbers of participants and large numbers of unique observers in proximate grid cells. In contrast, Tweeds Heads and Murwillumbah also had relatively large numbers of participants but few unique observers in proximate grid cells.

3.2. Observational accuracy

Crowdsourced koala observations were compared to the koala likelihood model across 173 grid cells in the study region. The grid cells were classified and symbolized into quintiles based on cell probability values (Fig. 2a) and total koala observations in each cell (Fig. 2b). Visually, there was a moderate degree of concordance, but there was also disagreement in some cells. The global Bivariate Moran's I statistic was 0.16 (pseudo p-value = 0.001), indicating weak but significant positive spatial autocorrelation between summed koala observations and neighbouring cell probabilities. Local spatial autocorrelation with high probability and high observations was significant in the south of the study area near Lismore, in the central study area, and on the north coast near Pottsville (Fig. 2c). Local spatial autocorrelation was also significant in the eastern reaches of the study area, and near Ballina where both cell probabilities and koala observation values were low.

The koala observation markers for the categories of *weekly*, *monthly*, *yearly*, *once*, and *dead/injured* were tabulated for each grid cell in the koala likelihood model. Spearman's rank correlations were calculated between cell probabilities and koala observation counts. The correlation coefficients and significance levels were as follows: *weekly* ($r = 0.40$, $p < 0.001$); *monthly* ($r = 0.40$, $p < 0.001$); *dead/injured* ($r = 0.30$, $p < 0.001$); *yearly* ($r = 0.30$, $p < 0.001$); and *once* ($r = 0.20$, $p < 0.01$). The correlation coefficient for *all observations combined* was $r = 0.38$, $p < 0.001$. For comparison, the correlation coefficient for "Great Koala Count" observations with cell probability values was $r = 0.48$, $p < 0.001$.

The mean cell probability values for each observation category were examined using ANOVA with post-hoc comparisons. The greatest accuracy was associated with *monthly* ($\bar{x} = 0.83$, $s = 0.17$) and *weekly* ($\bar{x} = 0.82$, $s = 0.21$) observation categories and the least accuracy with *yearly* ($\bar{x} = 0.74$, $s = 0.23$), *once* ($\bar{x} = 0.73$, $s = 0.21$), and *dead/injured* ($\bar{x} = 0.76$, $s = 0.19$) categories. The mean cell probabilities in the *monthly* and *weekly* categories were significantly larger than the cell probabilities in the *yearly*, *once*, and *dead/injured* categories (ANOVA, Tukey HSD, $p < 0.05$). Simply put, koala observations in shorter timeframe categories were more accurate than observations in longer timeframe categories.

The results of the presence/absence analysis are presented quantitatively (Table 2, Fig. 3) and show those grid cells that were inconsistent between the likelihood model and spatial survey (Fig. 3a) and field-based, citizen koala observations from the "Great Koala Count" (Fig. 3b). The presence/absence statistical association between spatial survey observations and historical observations in the likelihood model was weak, but significant (phi coefficient = 0.25, $p < 0.01$). The association between the "Great Koala Count" and the likelihood model was somewhat weaker than the spatial survey (phi coefficient = 0.21, $p < 0.01$). For the spatial survey, the presence/absence analysis indicated 96% consistency (137/142) in observations with the likelihood model where participants had observed koalas. The consistency was 19% (6/31) where participants had not observed koalas, but the model indicated historical presence of koalas. Of the inconsistent cell results, 70% of the cells were classified as low confidence in the likelihood model (Fig. 3c). For the field-based citizen observations, the presence/absence analysis indicated 100% consistency (69/69) in observations with the likelihood model where citizens had observed koalas. This result was expected given that citizen field observations from the Great Koala Count were included in the likelihood model. The consistency was 12% (11/93) where citizens did not observe koalas. Of the inconsistent cells, 51% were classified as low confidence in the likelihood model (Fig. 3d). Thus, both the spatial survey and field-based citizen observation performed well in matching historical records where koalas were observed, but both methods under-reported koala observations in cells where the model indicated koalas were present from historical records. Overall, the spatial survey had 30 inconsistent grid cells compared to 93 cells for the field-based citizen observations.

3.3. Participant predictors of accuracy

Bivariate correlation analysis and multiple linear regression models were run to determine which participant variables contributed to

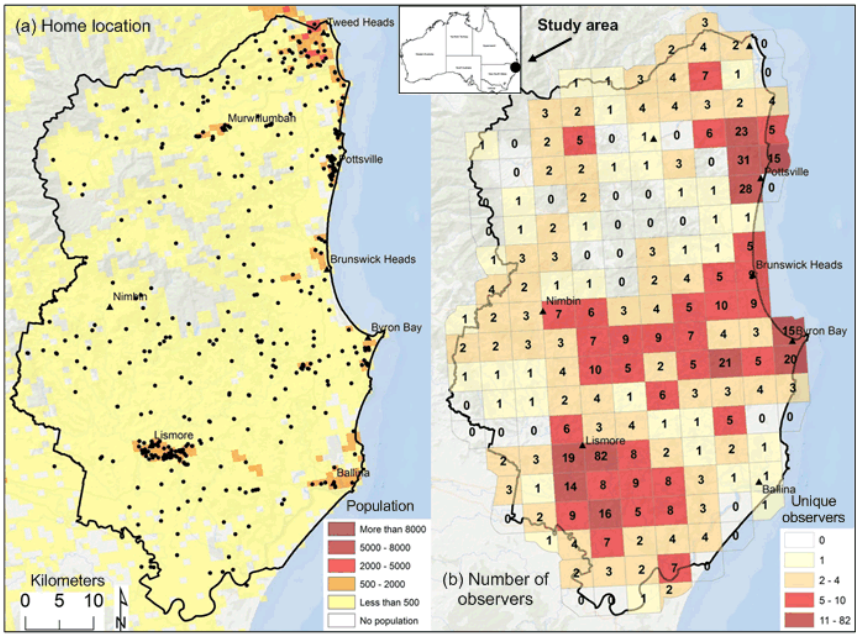


Fig. 1. Distribution of koala observers by (a) home location (points) with population grid in study area, and (b) number of unique koala observers located within 5 km grid cells in the koala likelihood model.

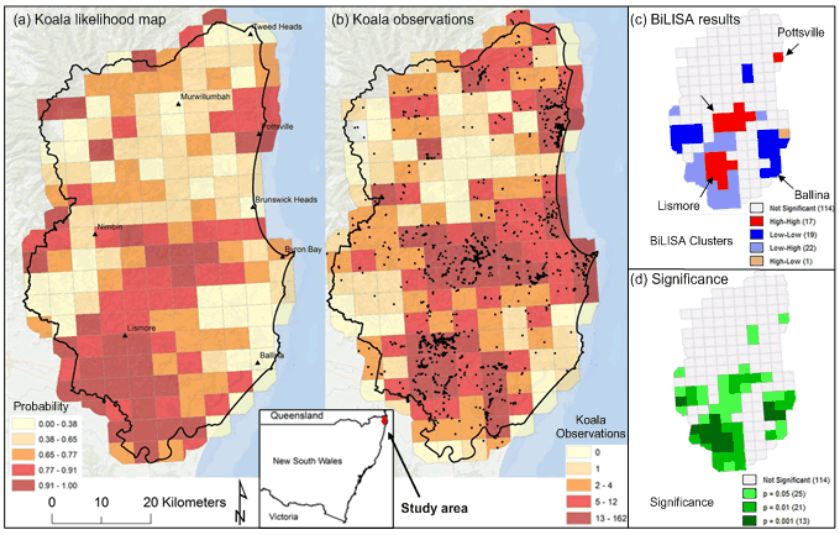


Fig. 2. Maps showing (a) Koala likelihood map with cell probabilities, (b) spatial distribution of koala observations from spatial survey (*weekly*, *monthly*, *yearly*, *once*, *dead/injured*) in the study area, (c) bivariate local indicators of spatial association (BiLISA), and (d) significance levels for BiLISA clusters. Cell probabilities and koala observations are categorized into quintiles for visual comparison.

observation accuracy as represented by koala cell probability values. The largest statistically significant bivariate correlations were found on the participant variables of *age*, *length of residence*, and self-rated *knowledge of koalas* (Table 3). The participant variables of *gender* and *distance from home* to observation were not significantly correlated with observation accuracy. All the regression models were statistically significant with Bonferroni corrections. The strongest predictive model was for *weekly* koala observations ($R = 0.52$, $p < 0.001$) followed by *dead/injured* observations ($R = 0.52$, $p < 0.001$). The weakest model was for *once* observations ($R = 0.31$, $p < 0.001$). The model for all observations combined was $R = 0.38$, $p < 0.001$.

The participant variables that best predicted cell probability values and standardized beta coefficients varied by the observation category model. The *combined* observations model had five significant predictor

Table 2
Presence/absence analysis for (a) spatial survey and (b) "Great Koala Count" with the likelihood model. Presence is one or more koala observations in the grid cell and absence is the lack of any observations.

(a) Great Koala Count[b]

			Absent	Present	
Likelihood Model	Absent	Count	11	0	11
		%	100.0%	0.0%	100.0%
	Present	Count	93	69	162
		%	57.4%	42.6%	100.0%
Total		Count	104	69	173
		%	60.1%	39.9%	100.0%
Model confidence levels for inconsistent cells		High	Medium	Low	Total
		27	18	48	93

(b) Spatial survey[a]

			Absent	Present	
Likelihood model	absent	Count	6	5	11
		%	54.5%	45.5%	100.0%
	present	Count	25	137	162
		%	15.4%	84.6%	100.0%
Total		Count	31	142	173
		%	17.9%	82.1%	100.0%
Model confidence levels for inconsistent cells		High	Medium	Low	Total
		6	3	21	30

[a] Phi coefficient = 0.25, $p < 0.01$.
[b] Phi coefficient = 0.21, $p < 0.01$.

variables and the *once* model had four significant predictor variables. Statistically significant predictor variables found in two or more of the six models were *knowledge of koalas* (5 models), *familiarity with the study area* (4), *age* (3), *length of residence* (3), and *education* (2). The *gender* and *distance from home* variables were not significant in any of the regression models while the *number of observations* was only significant in the *combined* model. Generalizing and interpreting the regression model results for all observations, older, more formally educated, long-term residents who were more knowledgeable about koalas made koala observations in locations with a higher likelihood of koala occurrence.

4. Discussion

This study examined the validity of crowdsourced wildlife (koala) observations from the two perspectives of *validity-as-accuracy* and *validity-as-credibility*. The *validity-as-accuracy* perspective analysed the accuracy of crowdsourced observations against a koala likelihood model using multiple measures of spatial concurrence while the *validity-as-credibility* perspective examined participant variables as potential sources of greater or lesser accuracy. There was significant spatial association between crowdsourced koala observations and the koala likelihood model. Where there were differences in the spatial results, there was lower confidence in the likelihood model due to fewer historical koala observations. Thus, there is the possibility that crowdsourced observations may represent more recent, changed conditions in the distribution or numbers of koalas within the study area. More accurate koala observations were contributed by older citizens with a higher level of self-rated knowledge of koalas, a higher level of formal education, and who had lived in the study area longer.

There are several important implications from this study. The first is that crowdsourced wildlife observations, if sufficient in number and

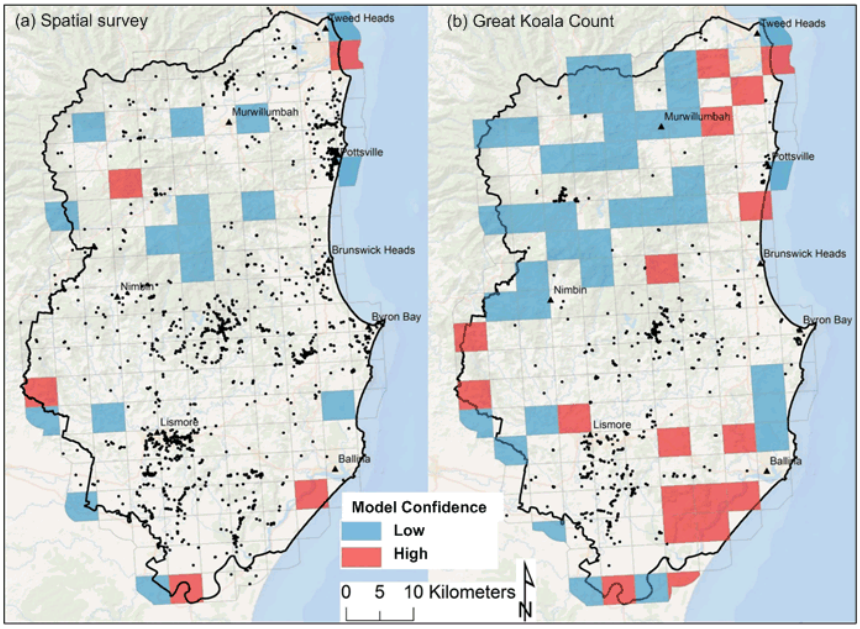


Fig. 3. Presence/absence analysis of koala likelihood model with citizen-based koala observations (black points) collected using two different methods: (a) Spatial survey, and (b) field-based "Great Koala Count". Grid cells with colour (red, blue) indicate koala presence in the likelihood model where there were no citizen observations. Blue cells indicate cells with low confidence in the model and red cells indicate high confidence. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 3
Regression model results using participant variables to predict koala cell probability values. Akaike Information Criterion (AIC) used to select "best" model. Bivariate correlations, model fit, standardized beta coefficients, and significance levels computed for the best model.

	All observations	Weekly	Monthly	Yearly	Once	Dead/injured
Number of cases	1451	238	271	415	388	139
Number of individuals	334	107	135	152	157	78
Mean cell probability (standard deviation)	0.77 (0.21)	0.82 (0.21)	0.83 (0.17)	0.74 (0.23)	0.73 (0.21)	0.76 (0.19)
Bivariate correlations						
Age	0.18***	0.36***	0.20***	0.11*	0.17***	0.16*
Length of residence	0.29***	0.35**	0.33***	0.26***	0.19***	0.45***
Familiarity with study area	−0.03	0.03	0.15***	0.01	−0.02	0.03
Knowledge of koalas	0.32***	0.38***	0.42***	0.21***	0.25***	0.50***
Education	0.13***	0.16**	0.28***	0.09*	0.02	0.24**
Gender[a]	−0.02	−0.09	0.04	−0.02	−0.03	−0.07
Number of observations	0.11***	0.26***	0.09	0.07	0.14**	0.08
Distance from home	−0.04	0.14*	−0.07	−0.07	−0.00	−0.02
Regression subsets analysis using AIC						
Number of potential models as good as the best model[b]	8	3	6	10	6	7
Probability that best model is best approximating model[c]	16%	26%	20%	14%	17%	19%
Best model						
Model fit	R = 0.38 Adj. R^2 = 0.14***	R = 0.52 Adj. R^2 = 0.25***	*R* = 0.46 Adj. R^2 = 0.20***	*R* = 0.32 Adj. R^2 = 0.09***	*R* = 0.31 Adj. R^2 = 0.12***	*R* = 0.52 Adj. R^2 = 0.25***
Standardized beta coefficients						
Age	0.12***	0.33***	Excluded	Excluded	0.17***	0.12
Length of residence	0.15***	Excluded	0.17*	0.32***	Excluded	Excluded
Familiarity with study area	−0.12***	−0.16**	0.08	−0.11*	−0.18***	−0.09
Knowledge of koalas	0.21***	0.27***	0.22**	0.09	0.35***	0.44***
Education	Excluded[d]	0.08	0.18**	Excluded	−0.17*	0.10
Gender[a]	0.04	Excluded	Excluded	0.09	Excluded	Excluded
Number of observations	0.10**	0.08	Excluded	Excluded	0.10	0.08
Distance from home	−0.04	Excluded	Excluded	−0.07	Excluded	Excluded

[a] Point-biserial correlation where Male = 1, Female = 2.
[b] Based on change in AIC values less than two (Richards, 2005).
[c] Based on Akaike weights.
[d] Variables excluded in best model based on AIC criterion.
* Significance $p < 0.05$.
** Significance $p < 0.01$.
*** Significance $p < 0.001$.

geographic scope, can be used to cross-validate and update wildlife distribution models. Wildlife populations, such as the koala, are dynamic, especially in a study area experiencing significant pressures on the populations from loss of koala habitat, human-induced mortality (e.g., from cars and dogs), and the spread of infectious diseases (Rhodes et al., 2011; Goldingay and Dobner, 2014; McAlpine et al., 2015; Lunney et al., 2016).

There is a temporal lag between observation data and the models constructed to estimate the koala distribution. The crowdsourced observation data could be used to continuously update and refine the koala likelihood model with more current observations of koala locations, similar to the way that annual bird counts can be used to monitor populations of bird species (Butcher et al., 1990; Horns et al., 2018; Niven et al., 2004). In this case, the koala likelihood model could be updated with citizen koala observations to adjust cell probability values and confidence levels. Given the koala is one of Australia's favourite animals (Woods, 2000; Shumway et al., 2015), a more frequent crowdsourced koala observation program (e.g., biennial) could be effective in updating koala distributions in the region.

Another implication is that citizen characteristics influence the quality of spatial data contribution. With crowdsourcing applications, it may not be possible, or even desirable, to directly select participants based on personal characteristics to enhance data quality given the potential social value of engaging a broad and diverse cross-section of the general public in wildlife conservation. However, indirect targeting of participants is possible through advertising and promotion channels that contain a higher proportion of individuals with desirable attributes. An example would be targeting news and information programming in community media whose listener demographics favour older individuals with higher levels of formal education, or Facebook advertisements that target older residents in the region. Wildlife welfare groups such as "Friend of the Koala" would be expected to have individuals with a greater knowledge and awareness of koalas than the general public, although our data did not indicate greater self-rated knowledge of koalas than the rest of the volunteer sample.

The spatial-survey approach to geographic citizen science offers several advantages over the field-based, citizen-science data collection projects, such as the "Great Koala Count" in South Australia. One advantage is the required level of effort to participate in the project. For the spatial survey, the only requirement is that participants have access to the internet to record their observations on a website. In contrast, to participate in field-based observations, participants need to own a Smartphone, download an application to record the specific locations of the koalas, and then upload their data to a website (Sequeira et al., 2014). The additional level of effort to record observations would depend on participant engagement with the activity, ranging from highly active, where participants intentionally travel to specific areas to seek out koalas, to passive engagement where sightings are opportunistic based on the participant's normal lifestyle routine. A second advantage is the ability to obtain much broader geographic coverage of koala observations across a large study area. This is particularly important in a relatively low-density, rural landscape compared with Sequeira et al. (2014) which was largely city-based, and had a greater pool of potential participants to draw from. Both spatial social surveys and field-based observations will contain geographic bias based on participant location, but koala observations from spatial surveys are more likely to cover larger geographic areas, including locations that are more distant from population centres.

There are important limitations of spatial surveys compared to field observations. The most important limitation is the loss of spatial accuracy (resolution) in the recording of koala observations. Field studies use GPS-enabled devices to record locations while spatial surveys record locations using digital markers on a base-map. Field studies can achieve resolution within a few meters while spatial surveys are only likely to be accurate within a few hundred meters. This difference in resolution is not likely to be important when assessing regional geographic distributions (e.g., using 5 km grid cells) if the species in question has a large home range. In the case of the koala, home ranges cover many hectares and koalas regularly travel 100 s of meters per night (Goldingay and Dobner, 2014; Matthews et al., 2016).

A second limitation is that spatial surveys rely on participant memory recall for both the number of observations and locations, resulting in potential temporal and spatial inaccuracy of koala sightings. Lunney et al. (2016) applied the concept of a "forgetting curve" to adjust historical community koala observation data. The "forgetting curve" is a non-linear function in which people remember recent events more than older events (Averell and Heathcote, 2011). In this study, under-reporting of past koala sightings due to limitations in memory recall is likely to have occurred, but the magnitude is unknown. Under the assumption that more recent memories would be more accurate and comprehensive, one could posit that the koala mapping frequency categories of *weekly* or *monthly* may be more accurate than the categories of *yearly* or *once*. Indeed, the *weekly* and *monthly* observation categories were more highly correlated with likelihood model probabilities than the *yearly* or *once* categories, and the mean cell probabilities were significantly larger than the *yearly* and *once* categories. However, without additional information about the observations (e.g., the data/time of the koala observation), it would be difficult to estimate the loss of accuracy and completeness in koala observations associated with memory recall.

A further limitation of spatial surveys is the ambiguity regarding absence data. In this study, participants recorded the location of koala sightings, but not locations where no koalas were seen. Without explicit koala absence mapping by participants, there is ambiguity as to how to interpret the status of areas that do not have mapped locations. Our view is that the absence of mapped koala locations does not indicate the absence of koalas per se because the absence of observations could be explained by incomplete geographic coverage from crowdsourcing. Other researchers have noted the need to collect koala absence data in addition to koala presence data (Flower et al., 2016; Sequeira et al., 2014) to more accurately estimate koala distribution. An approach to absence data has been calculated for koalas by using other, well-known species, as markers for a location of a survey site (Lunney et al., 2009; Predavec et al., 2018).

5. Conclusion

There is strong evidence for the potential of citizen science to contribute to biodiversity research (Predavec et al., 2016; Theobald et al., 2015), which includes crowdsourced geographic citizen science. Yet a relatively small percentage of citizen science data actually reach publication, suggesting the growing citizen science movement is only realizing a small portion of its potential impact (Theobald et al., 2015). To be more effective, participatory mapping for koala conservation, and wildlife conservation in general, would benefit from implementing some of the following recommendations:

1. Broaden recruitment efforts to include household sampling, not just volunteers, to achieve greater geographical representation and study area coverage. This is especially important for rural areas with low population density. Although household survey response rates are typically low and continue to decline (Connelly et al., 2003; Harris and Goldingay, 2003), household recruitment remains an important means to obtain more representative geographic coverage in participatory mapping. The use of internet panels for participant recruitment can increase geographic coverage, but internet panels produce lower quality spatial data compared to other sampling methods (Brown et al., 2012; Brown, 2017).
2. Include absence markers as a component of the spatial survey to be mapped by participants. Absence data are important in estimating wildlife populations and distributions (e.g., Guillera-Arroita et al., 2015; Lunney et al., 2017). Absence mapping does not have to be extensive to be useful. For example, one could ask the participants to place five markers where they expected to see koalas, but did not. With the nearly 400 participants in this study, this minimal effort would have produced 2000 absence locations. However, as a caveat, perceived absence of koalas does not equal real absence.
3. Consider including other fauna sightings as part of the mapping protocol. The lack of absence data in the first NSW state-wide community koala survey in 1986–87 (Reed et al., 1990) presented problems in determining the distribution data. To overcome them, the comparable 2006 NSW survey by Lunney et al. (2009) included a selection of nine other species. The koala likelihood model uses other faunal sightings to generate koala probabilities. However, given that participant mapping effort is finite and increasing the number of spatial attributes to be mapped does not increase the amount of spatial data collected (Brown, 2017), the type and number of markers to be included necessarily involves survey design trade-offs. This study also included the mapping of land use preferences in the region to engage participants. Some of these mapping attributes would need to be eliminated from the mapping interface to collect other faunal data. Geographic citizen science projects involving observations of species other than koalas may confront similar trade-offs. Here, the selection of the other species matters – the animals have to be important (endangered or a pest), unique (koala, platypus), and charismatic (or loathed).
4. Enhance the participatory mapping interface design and user support. The degree of public engagement depends significantly on system usability and the participants' satisfaction with using the system (Meng and Malczewski, 2010). Although mapping in our study was designed to be simple and used a familiar "drag and drop" marker procedure on the most widely used Google Maps interface, a significant number of participants (> 30) quit the application after identifying their home location, the first marker requested to be mapped. This "drop-out" of participants may represent frustration with the mapping interface. This application, and geographic citizen science projects in general, would benefit from a user-centred design approach (Haklay and Tobón, 2003) that includes a systematic useability study before implementation. Further, Newman et al. (2010) provide guidelines to improve citizen science web mapping applications.

Given that the NSW government, in mid-2018, has committed $45 million to koala conservation through its recently-released koala strategy, and the Commonwealth government is committed to preparing a koala recovery plan for the States (ACT, NSW, Queensland) where the koala is listed by the Commonwealth government as vulnerable, it is crucial to provide the best scientific advice possible. However, it is evident that pressure groups, local biases, or shallow committee interpretations can lead to unbalanced decisions for action and the recommendations for the allocation of funds (Shumway et al., 2015). The approach to spatially-explicit, citizen science explored in this study provides a reliable and repeatable means of resolving these problems. However, while citizen science can contribute to identify species presence and may help identify changes in distribution, it should augment, not replace long-term systematic scientific surveys and monitoring.

The koala is a charismatic species, and it can serve a broader conservation and management function than just its own survival (Lunney, 2012). The location we selected for our study – the north coast of NSW-

has almost every koala conservation and management problem that exists (McAlpine et al., 2015), except for crippling droughts as experienced in the drier regions west of the Great Divide (Lunney et al., 2012) and overpopulation, but climate change is gradually shrinking coastal koala populations in NSW (Lunney et al., 2014). Given the great geographic spread of the koala from north Queensland to South Australia (Adams-Hosking et al., 2016), detailed, on-ground, labour-intensive surveys are not feasible except in a few locations. Geographic citizen science, as outlined in this study, provides a way forward so that local government, such as the four LGAs in this study, or each State government, or all the range States simultaneously, can gain a reliable grasp of the conservation and management issues facing koalas. An important contribution of our study was to provide evidence that citizen science spatial surveys are a useful investment when considering options for allocating time and money to the raft of conservation and management problems confronting the koala.

Acknowledgements

This research was funded by the Australian Research Council, ARC Linkage Project grant number LP160100186. The research team expresses gratitude to the local governments of Ballina Shire, Byron Shire, City of Lismore, and Tweed Shire for their cooperation in the study, and the residents of New South Wales who participated in the study. We also acknowledge the cooperation of Dr. Martin Predavec, Office of Environment and Heritage NSW, who generously provided access to the most current data for the koala likelihood model.

References

Adams-Hosking, C., McBride, M.F., Baxter, G., Burgman, M., Villiers, D., Kavanagh, R., ... Molsher, R., 2016. Use of expert knowledge to elicit population trends for the koala (*Phascolarctos cinereus*). Divers. Distrib. 22 (3), 249–262.

Akaike, H., 1974. A new look at the statistical model identification. IEEE Trans. Autom. Control 19 (6), 716–723.

Alabri, A., Hunter, J., 2010, December. Enhancing the quality and trust of citizen science data. In: e-Science (e-Science), 2010 IEEE Sixth International Conference on. IEEE, pp. 81–88.

Antoniou, V., Skopeliti, A., 2015. Measures and indicators of VGI quality: an overview. In: ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences. 2. pp. 345.

Australian Bureau of Statistics, 2016. 2016 Census. QuickStats. http://www.abs.gov.au/websitedbs/D3310114.nsf/Home/2016%20QuickStats Retrieved 16 April 2018.

Averell, L., Heathcote, A., 2011. The form of the forgetting curve and the fate of memories. J. Math. Psychol. 55 (1), 25–35.

Bonney, R., Cooper, C.B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K.V., Shirk, J., 2009. Citizen science: a developing tool for expanding science knowledge and scientific literacy. Bioscience 59 (11), 977–984.

Brown, G., 2012. An empirical evaluation of the spatial accuracy of public participation GIS (PPGIS) data. Appl. Geogr. 34, 289–294.

Brown, G., 2017. A review of sampling effects and response bias in internet participatory mapping (PPGIS/PGIS/VGI). Trans. GIS 21 (1), 39–56.

Brown, G., Kyttä, M., 2014. Key issues and research priorities for public participation GIS (PPGIS): a synthesis based on empirical research. Appl. Geogr. 46, 122–136.

Brown, G., Weber, D., Zanon, D., de Bie, K., 2012. Evaluation of an online (opt-in) panel for public participation geographic information systems (PPGIS) surveys. Int. J. Public Opin. Res. 24, 534–545.

Brown, G., Weber, D., de Bie, K., 2015. Is PPGIS good enough? An empirical evaluation of the quality of PPGIS crowd-sourced spatial data for conservation planning. Land Use Policy 43, 228–238.

Butcher, G.S., Fuller, M.R., McAllister, L.S., Geissler, P.H., 1990. An evaluation of the Christmas bird count for monitoring population trends of selected species. Wildl. Soc. Bull. 18 (2), 129–134.

Cleary, G. n.d. 2014 Koala Count Report. National Parks Association of NSW. Available at: [Accessed August 11, 2018].

Cohn, J.P., 2008. Citizen science: can volunteers do real research? Bioscience 58 (3), 192–197.

Connelly, N.A., Brown, T.L., Decker, D.J., 2003. Factors affecting response rates to natural resource-focused mail surveys: empirical evidence of declining rates over time. Soc. Nat. Resour. 16 (6), 541–549.

Cox, C., Morse, W., Anderson, C., Marzen, L., 2014. Applying public participation geographic information systems to wildlife management. Hum. Dimens. Wildl. 19 (2), 200–214.

Fitz-Gibbon, C., Morris, L., 1987. How to Analyze Data. SAGE Publications, Newbury Park, CA.

Flower, E., Jones, D., Bernede, L., 2016. Can citizen science assist in determining koala (*Phascolarctos cinereus*) presence in a declining population? Animals 6 (7), 42.

Girres, J.F., Touya, G., 2010. Quality assessment of the French OpenStreetMap dataset. Trans. GIS 14 (4), 435–459.

Goldingay, R.L., Dobner, B., 2014. Home range areas of koalas in an urban area of north-east New South Wales. Aust. Mammal. 36, 74–80.

Goodchild, M.F., 2007. Citizens as sensors: the world of volunteered geography. GeoJournal 69 (4), 211–221.

Guillera-Arroita, G., Lahoz-Monfort, J.J., Elith, J., Gordon, A., Kujala, H., Lentini, P.E., ... Wintle, B.A., 2015. Is my species distribution model fit for purpose? Matching data and models to applications. Glob. Ecol. Biogeogr. 24 (3), 276–292.

Haklay, M., 2010. How good is volunteered geographical information? A comparative study of OpenStreetMap and Ordnance Survey datasets. Environ. Plann. B. 37, 682–703.

Haklay, M., 2013. Citizen science and volunteered geographic information: overview and typology of participation. In: Sui, D., Elwood, S., Goodchild, M. (Eds.), Crowdsourcing Geographic Knowledge. Springer, Dordrecht.

Haklay, M., Tobón, C., 2003. Usability evaluation and PPGIS: towards a user-centred design approach. Int. J. Geogr. Inf. Sci. 17 (6), 577–592.

Harris, J.M., Goldingay, R.L., 2003. A community-based survey of the koala *Phascolarctos cinereus* in the Lismore region of north-eastern New South Wales. Aust. Mammal. 25 (2), 155–167.

Hollow, B., Roetman, P.E., Walter, M., Daniels, C.B., 2015. Citizen science for policy development: the case of koala management in South Australia. Environ. Sci. Pol. 47, 126–136.

Horns, J.J., Adler, F.R., Şekercioğlu, Ç.H., 2018. Using opportunistic citizen science data to estimate avian population trends. Biol. Conserv. 221, 151–159.

Howe, J., 2006. The rise of crowdsourcing. Wired Mag. 14 (6), 1–4.

Hunter, J., Alabri, A., Ingen, C., 2013. Assessing the quality and trustworthiness of citizen science data. Concurrency Comput. Pract. Experience 25 (4), 454–466.

Lunney, D., Craig, Robin Kundis, Pardy, Bruce, Nagle, John Copeland, Schmitz, Oswald, Smith, William, 2012. Charismatic megafauna. Pp 63-66 in the Encyclopedia of sustainability: vol. 5. In: Ecosystem Management and Sustainability. Berkshire Publishing, USA, Great Barrington, MA.

Lunney, D., Crowther, M.S., Shannon, I., Bryant, J.V., 2009. Combining a map-based public survey with an estimation of site occupancy to determine the recent and changing distribution of the koala in New South Wales. Wildl. Res. 36 (3), 262–273.

Lunney, D., Crowther, M.S., Wallis, I., Foley, W., Lemon, J., Wheeler, R., Madani, G., Orscheg, C., Griffith, J., Krockenberger, M., Retamales, M., Stalenberg, E., 2012. Koalas and climate change: a case study on the Liverpool Plains, north-west NSW. In: Lunney, D., Hutchings, P. (Eds.), Wildlife and Climate Change: Towards Robust Conservation Strategies for Australian Fauna. Royal Zoological Society of NSW, Mosman NSW, Australia, pp. 150–168.

Lunney, D., Stalenberg, E., Santika, T., Rhodes, J.R., 2014. Extinction in Eden: identifying the role of climate change in the decline of the koala in south-eastern NSW. Wildl. Res. 41 (1), 22–34.

Lunney, D., Predavec, M., Miller, I., Shannon, I., Fisher, M., Moon, C., Rhodes, J., Matthews, A., Turbill, J., 2016. Interpreting patterns of population change in koalas from long-term datasets in Coffs Harbour on the north coast of New South Wales. Aust. Mammal. 38, 29–43.

Lunney, D., Stalenberg, E., Santika, T., Rhodes, J., 2017. A rebuttal to 'mooted extinction of koalas at Eden. Improving the information base' - a misleading, even dangerous, polemic. Wildl. Res. 44, 453–457.

Matthews, A., Lunney, D., Gresser, S., Maitz, W., 2016. Movement patterns of koalas in remnant forest after fire. Aust. Mammal. 38 (1), 91–104.

McAlpine, C.A., Lunney, D., Melzer, A., Menkhorst, P., Stephen Phillips, S., Phalen, D., Ellis, W., Foley, W., Baxter, G., de Villiers, D., Kavanagh, R., Adams-Hosking, C., Todd, C., Whisson, D., Molsher, R., Walter, M., Lawler, I., Close, R., 2015. Conserving koalas: a review of the contrasting regional trends, outlooks and policy challenges. Biol. Conserv. 192, 226–236.

Meng, Y., Malczewski, J., 2010. Web-PPGIS usability and public engagement: a case study in Canmore, Alberta, Canada. J. Urban Reg. Inf. Syst. Assoc. 22 (1).

Newman, G., Zimmerman, D., Crall, A., Laituri, M., Graham, J., Stapel, L., 2010. User-friendly web mapping: lessons from a citizen science website. Int. J. Geogr. Inf. Sci. 24 (12), 1851–1869.

Niven, D.K., Sauer, J.R., Butcher, G.S., Link, W.A., 2004. Christmas bird count provides insights into population change in land birds that breed in the boreal forest. American Birds 58 (104th Christmas Bird), 10–20.

Office of Environment and Heritage (OEH), 2016. Modification of the Preliminary Map of the Likelihood of Koalas within NSW for Use in Private Native Forestry Applications. Office of Environment and Heritage, Government of New South Wales Available at: https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/forestagreements/modification-preliminary-map-likelihood-koalas-within-nsw-160601.pdf?la=en&hash=F6007154F34B6CA99AAC040755928873C6D12D89, Accessed date: 21 June 2018.

Paul, K., Quinn, M.S., Huijser, M.P., Graham, J., Broberg, L., 2014. An evaluation of a citizen science data collection program for recording wildlife observations along a highway. J. Environ. Manag. 139, 180–187.

Phillips, S., Callaghan, J., 2011. The spot assessment technique: a tool for determining localised levels of habitat use by koalas *Phascolarctos cinereus*. Aust. Zool. 35 (3), 774–780.

Predavec, M., Lunney, D., Scotts, D., Turbill, J., Shannon, Ian, 2014. A Preliminary Map of the Likelihood of Koala Occurrence in NSW for Use in Private Native Forestry Applications. Office of Environment and Heritage, Government of New South Wales Available at: http://www.epa.nsw.gov.au/your-environment/native-forestry/mapping-research/koala-mapping-program/mapping-koala-occurrence, Accessed date: 21 June 1918.

Predavec, M., Lunney, D., Shannon, I., Scotts, D., Turbill, J., Faulkner, B., 2015. Mapping the likelihood of koalas across New South Wales for use in private native forestry: developing a simple, species distribution model that deals with opportunistic data. Aust. Mammal. 37 (2), 182–193.
Predavec, M., Lunney, D., Hope, B., Stalenberg, E., Shannon, I., Crowther, M.S., Miller, I., 2016. The contribution of community wisdom to conservation ecology. Conserv. Biol. 30, 496–505.
Predavec, M., Lunney, D., Shannon, I., Lemon, J., Sonawane, I., Crowther, M., 2018. Using repeat citizen science surveys of koalas to assess their population trend in the north-west of New South Wales: scale matters. Aust. Mammal. 40 (1), 47–57.
Reed, P., Lunney, D., Walker, P., 1990. Survey of the koala *Phascolarctos cinereus* (Goldfuss) in New South Wales (1986-87), with an ecological interpretation of its distribution. In: Lee, A.K., Handasyde, K.A., Sanson, G.D. (Eds.), Biology of the Koala. Surrey Beatty and Sons, Chipping Norton, NSW, pp. 55–74.
Rhodes, J.R., Ng, C.F., de Villiers, D.L., Preece, H.J., McAlpine, C.A., Possingham, H.P., 2011. Using integrated population modelling to quantify the implications of multiple threatening processes for a rapidly declining population. Biol. Conserv. 144, 1081–1088.
Richards, S.A., 2005. Testing ecological theory using the information-theoretic approach: examples and cautionary results. Ecology 86, 2805–2814.
Schmeller, D.S., Henry, P.Y., Julliard, R., Gruber, B., Clobert, J., Dziock, F., et al., 2009. Advantages of volunteer-based biodiversity monitoring in Europe. Conserv. Biol. 23, 307–316.
Scotts, D., Turbill, J., Predavec, M., Lunney, D., Faulkner, B., Smith, Jill, 2014. A Preliminary Map of the Likelihood of Koala Occurrence in NSW: Comparison of Preliminary Baseline Likelihood of Occurrence Mapping with Koala Habitat Mapping on the NSW North Coast. Office of Environment and Heritage, Government of New South Wales Available at: http://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/epa/140868koalamapsubproj.pdf?la=en, Accessed date: 21 June 2018.
Sequeira, A.M., Roetman, P.E., Daniels, C.B., Baker, A.K., Bradshaw, C.J., 2014. Distribution models for koalas in South Australia using citizen science-collected data. Ecol. Evol. 4 (11), 2103–2114.
Shumway, N., Lunney, D., Seabrook, L., McAlpine, C., 2015. Saving our national icon: an ecological analysis of the 2011 Australian Senate inquiry into status of the koala. Environ. Sci. Pol. 54, 297–303.
Spielman, S.E., 2014. Spatial collective intelligence? Credibility, accuracy, and volunteered geographic information. Cartogr. Geogr. Inf. Sci. 41 (2), 115–124.
Sullivan, B.L., Wood, C.L., Iliff, M.J., Bonney, R.E., Fink, D., Kelling, S., 2009. eBird: a citizen-based bird observation network in the biological sciences. Biol. Conserv. 142 (10), 2282–2292.
Theobald, E.J., Ettinger, A.K., Burgess, H.K., Debey, L.B., Schmidt, N.R., Froehlich, H.E., ... Parrish, J.K., 2015. Global change and local solutions: tapping the unrealized potential of citizen science for biodiversity research. Biol. Conserv. 181, 236–244.
Van Exel, M., Dias, E., Fruijtier, S., 2010. The impact of crowdsourcing on spatial data quality indicators. In: Proceedings of the 6th GIScience International Conference on Geographic Information Science, pp. 213–217.
van Strien, A.J., van Swaay, C.A., Termaat, T., 2013. Opportunistic citizen science data of animal species produce reliable estimates of distribution trends if analysed with occupancy models. J. Appl. Ecol. 50 (6), 1450–1458.
Woods, B., 2000. Beauty and the beast: preferences for animals in Australia. J. Tour. Stud. 11 (2), 25.
Zielstra, D., Zipf, A., 2010. A comparative study of proprietary geodata and volunteered geographic information for Germany. In: 13th AGILE International Conference on Geographic Information Science, Guimarães (PRT), (4 Jun 2010, 15 p.).

Report No. 4.4 **Minutes of previous meeting held 14 June 2018**
Directorate: Sustainable Environment and Economy
Report Author: Michelle Chapman, Project Support Officer
File No: I2018/1921
Theme: Sustainable Environment and Economy
Planning Policy and Natural Environment

Summary:

The minutes of the previous Biodiversity Advisory Committee meeting held on 14 June 2018 and referred to at Item 3 of this meeting's agenda, are attached.

RECOMMENDATION:

That the Biodiversity Advisory Committee note the minutes of 14 June 2018 meeting which were reported to 2 August Council meeting.

Attachments:

1 Minutes 14/06/2018 Biodiversity Advisory Committee, I2018/1104 , page 28⇩

Report

The minutes of the previous Biodiversity Advisory Committee meeting held on 14 June 2018 are attached and available at:

https://byron.infocouncil.biz/RedirectToDoc.aspx?URL=Open/2018/06/BAC_14062018_MIN_872.PDF

The minutes were reported to 2 August Council meeting, resulting in resolution:

18-457 *Resolved that Council note the minutes of the Biodiversity Advisory Committee Meeting held on 14 June 2018.*

Financial Implications

Nil

Statutory and Policy Compliance Implications

Nil

MINUTES OF MEETING

BIODIVERSITY ADVISORY COMMITTEE MEETING

Venue	**Bus Field Trip - Ewingsdale**
Date	**Thursday, 14 June 2018**
Time	**2.00pm**

Minutes of the Biodiversity Advisory Committee Meeting held on Thursday, 14 June 2018
File No: Error! Unknown document property name.

PRESENT: Cr C Coorey, Cr S Ndiaye, Cr S Richardson, Cr A Hunter, Cr B Cameron

Staff: Sharyn French (Manager Environmental and Economic Planning)

Community: Peter Westheimer, Greg Shanahan

Invited guest: Tony Kenway

The meeting was held as a bus tour to a 40 acre wetland project (cabinet timber and rainforest regeneration) at Seapeace, Ewingsdale as an example of best practice of an agri-environment project.

APOLOGIES:

Cr J Martin, Luke McConell

DECLARATIONS OF INTEREST – PECUNIARY AND NON-PECUNIARY

There were no declarations of interest.

ADOPTION OF MINUTES FROM PREVIOUS MEETINGS

The minutes of the meeting held on 30 April were resolved by Council at the Ordinary Meeting held on 24 May 2018.

BUSINESS ARISING FROM PREVIOUS MINUTES

There was no business arising from previous minutes.

There being no further business the meeting concluded at 4.30pm.

STAFF REPORTS - INFRASTRUCTURE SERVICES

Report No. 4.5 **Suffolk Beachfront Holiday Park Dog Friendly Status**
Directorate: Infrastructure Services
Report Author: Pattie Ruck, Open Space Facilities Coordinator
File No: I2018/1889
Theme: Infrastructure Services
Suffolk Park Holiday Park

Summary:

Council Resolved on 20 September 2018.

18-625 Resolved:

1. *That Council adopt Suffolk Beachfront Holiday Park as a Dog Friendly Park in accordance with the dog friendly site map, during off peak times*

2. *Request that the Biodiversity Advisory Committee provide an assessment on potential impacts of the change in status of the Suffolk Beachfront Holiday Park to a Dog Friendly Park on the surrounding environment*

3 *That Council increase ranger patrols in this area, as per availability, to ascertain any increased non-compliance*

(Spooner/Hackett) .

Upon adoption of this Dog Friendly Park Council requested the attached report 13.19 (I2018/1269) be sent to the Biodiversity Advisory Committee for assessment on potential impacts of the change in status of the Park on the surrounding environment.

RECOMMENDATION:

That the Biodiversity Advisory Committee note the report and provide feedback on the potential impacts of the change in status of the Suffolk Beachfront Holiday Park to a Dog Friendly Park on the surrounding environment.

Attachments:

1 REPORT 20 09 2018 COUNCIL SUFFOLK BEACHFRONT HOLIDAY PARK DOG FRIENDLY REPORT, E2018/81753 , page 33⇩
2 Pet Friendly Park Terms and Conditions - Guests to understand and sign - July 2018, E2018/57756 , page 42⇩

Report

Upon adoption of Suffolk Beachfront Holiday Park as a Dog Friendly Park, Council requested the attached report 13.19 (I2018/1269) be sent to the Biodiversity Advisory Committee for feedback on potential impacts of the change in status of the Park on the surrounding environment.

Financial Implications

Nil

Statutory and Policy Compliance Implications

Included in attached report 13.19 (I2018/1269).

BYRON SHIRE COUNCIL
STAFF REPORTS - INFRASTRUCTURE SERVICES 13.19

Report No. 13.19 **Suffolk Beachfront Holiday Park Dog Friendly Report**
Directorate: Infrastructure Services
Report Author: Pattie Ruck, Open Space Facilities Coordinator
File No: I2018/1269
Theme: Infrastructure Services
Suffolk Park Holiday Park

Summary:

To provide a report on Dog Friendly Trial Results at Suffolk Beachfront Holiday Park and recommend Dog Friendly Status based on these results.

RECOMMENDATION:

That Council adopt Suffolk Beachfront Holiday Park as a Dog Friendly Park in accordance with the dog friendly site map, during off peak times.

Attachments:

1 Dog Friendly Park Rules, E2018/57756
2 Feedback on Dog Friendly Trial at Suffolk Beachfront Holiday Park, E2018/59006

Report

Dog Friendly Trial

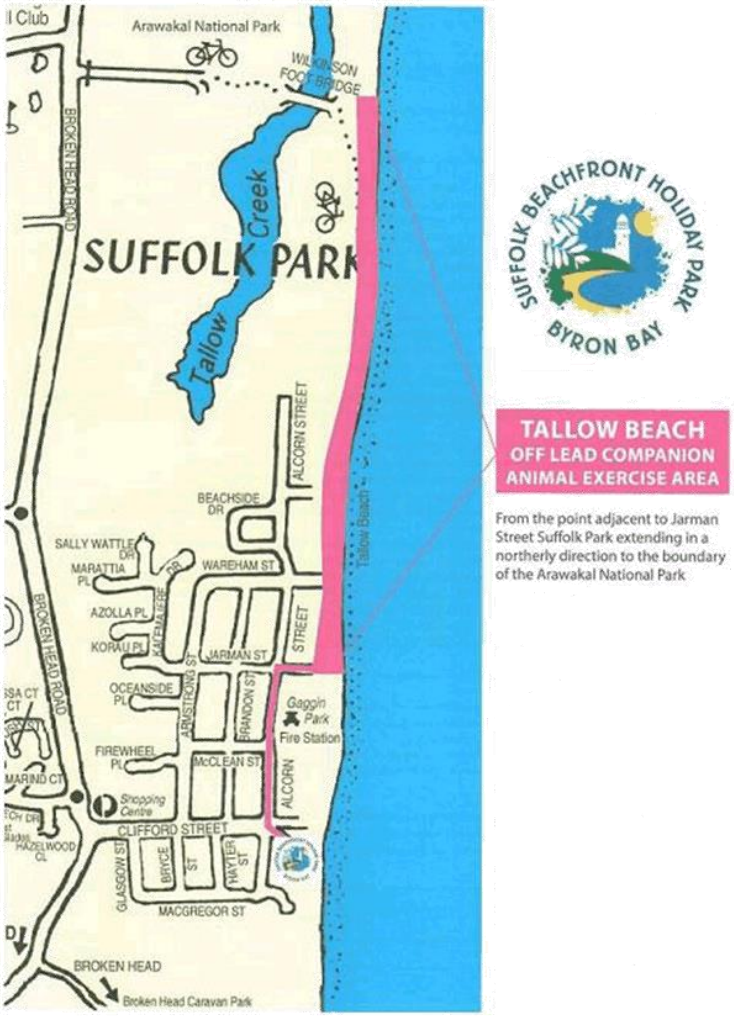
The initial trial period commenced in late 2016 and was extended until the finalisation of this report.

Consultation prior, during, and post trial period has been undertaken with the Park Managers, permanent residents, and short term guests. Written feedback was received from Park Mangers, residents, and short term guests throughout the dog friendly period. The trial period excluded peak periods and busy times.

Dog Friendly Park Rules and Associated Procedures

During the trial the Park Managers implemented strict dog friendly park rules, as attached (E2018/57756). Upon guest check-in these rules were signed and understood by dog friendly guests and the below map provided.

Map depicting access point to Off Lead Companion Area from Suffolk Beachfront Holiday Park



BYRON SHIRE COUNCIL
STAFF REPORTS - INFRASTRUCTURE SERVICES 13.19

Appropriate signage placed throughout the park and beach access points.

Beach access points within the park

Signs inside the BBQ Area

Dogs NOT PERMITTED signs near camp kitchen and laundry.

Dog Friendly Sites Available Map

P = Dog friendly sites – Sites 23 to 50 = 32 Sites
OP = Overflow Dog friendly sites – used as overflow only when P sites are full – Sites 4 to 9 & 17 to 21 = 11 Sites
Dog friendly site locations selected considering proximity separation from permanent residents.

Dog Friendly Feedback

BYRON SHIRE COUNCIL
STAFF REPORTS - INFRASTRUCTURE SERVICES 13.19

Feedback and Mitigation measures implemented on feedback items

The table below displays a summary of feedback items received. Summary of the details of where the feedback was from, how many submissions were received, and documentation reference details are attached.

Unsupportive Submissions - One submission signed by eight of the permanent residents. Two negative submissions received individually from two permanent residents who also signed the group submission. One negative submission received from a regular short term guest.

Supportive Submissions - Two positive submissions received from permanent residents. Council has received positive feedback from written letters, facebook comments, and wikiCamp reviews. One positive feedback received in writing from a short term guest, six positive comments on Facebook and nine positive comments on wikiCamps.

Feedback Item	Mitigation Measure
Dogs off leads	• Dog friendly park rules explained to guests upon check in and signed by guests to acknowledge requirements of the park. • Managers communicate with offending guests ASAP and ensure compliance. If non-compliance is ongoing the guests will be required to leave. • Occasionally dogs from outside of the park wonder through. There has been occasions throughout the trial this has occurred and after enquiring with guests, these particular dogs were not from guests staying at the park and did not match the description of their types of dogs. This issue is ongoing and hard to mitigate with or without a pet friendly status. Possible fencing could be looked at in the future if this issue is heightened and cost/benefit is feasible.
Complaints from other guests/residents regarding barking and roaming dogs.	• Managers act upon the requests ASAP and ensure compliance where applicable. • Complaints are looked into ASAP by the managers and mitigation measure actioned.
Dog droppings	• Guests are briefed and required to sign on dog friendly park rules. • Managers inspect the sites daily to ensure sites and surrounds are free from droppings. There were two occasions this occurred during the trial. • Bag dispensers provided if problem persists.
Dogs taken onto the beach through non dog friendly access points	• Signs indicate where Dogs are NOT PERMITTED are in place at access points. • Upon check in guests are verbally told and provided a map detailing access points.
Effect on wildlife	• Park rules ensure dogs are tied up, therefore unable to chase after wildlife. If wildlife was to approach the dog this is unable to be mitigated.
Complaints from permanent residents	• Dog Friendly Sites are separated from the permanent residents and the overflow sites are separated by a minimum road width. Throughout the trial there were issue when the managers allowed pets throughout the whole park. However, this was resolved and the managers are to ensure there is always separation from the residents as per the map displayed above.

Dog Friendly Seasonal Dates

Seasonal dates throughout Suffolk Park for 18/19 was adopted by Council on 28 June 2018 along with the fees and charges. These seasonal dates will continue to be included in the annual fees and charges process.

BYRON SHIRE COUNCIL
STAFF REPORTS - INFRASTRUCTURE SERVICES 13.19

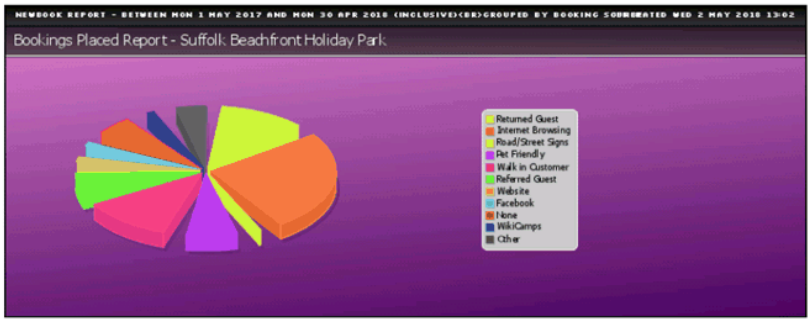
Peak times will be *excluded* from dog friendly status. The adopted peak seasonal dates for Suffolk Beachfront Holiday Park run from 22 December 2018 to 14 January 2019 (Christmas holidays) and 17 April 2019 to 27 April 2019 (Easter, ANZAC, NSW and QLD School holidays). Major festivals fall under this peak category and these festival dates change annual. Seasonal dates outside of the adopted peak dates will be available to guests as dog friendly. As *peak times* are *excluded* as dog friendly periods within the park, permanent residents will not be able to have a pet friendly status. This procedure mitigates any risk of ongoing permanent dog related issues. Short term guests are required to leave if their dog is a nuisance.

Financial Implications

The minimum financial increase from dog friendly bookings from 1 May 2017 to 30 April 2018 was $64,940.78. The Park Managers have indicated this figure does not include website or internet browsing bookings that are dog friendly bookings. 9.13% of overall bookings are related to pet friendly bookings. There was no decline noted in regular bookings that were not dog friendly guests. Additional infrastructure is not required by Council. If Suffolk Park is not to continue as a Dog Friendly Holiday Park Council acknowledges the potential for declined income and recognises a need to honour pet friendly bookings already taken until 2 October 2018.

Bookings Placed Report
Between Mon 1 May 2017 and Mon 30 Apr 2018 (Inclusive)
Grouped By Booking Source

Suffolk Beachfront Holiday Park



Booking Source	Total Bookings	Active Bookings	Cancelled Bookings	Projected Revenue	Average Revenue (per Booking)	Average Length	Booking Source Percentage
Internet Browsing	1944	1742	202	$327,469.73 CR	$168.45 CR	3 Nights	35.66%
Walk in Customer	874	852	22	$71,138.43 CR	$81.39 CR	2 Nights	16.03%
Returned Guest	827	716	111	$162,976.70 CR	$197.07 CR	6 Nights	15.17%
Pet Friendly	498	459	39	$64,940.78 CR	$130.40 CR	4 Nights	9.13%
Referred Guest	404	347	57	$87,655.00 CR	$216.97 CR	4 Nights	7.41%
None	360	286	74	$44,051.00 CR	$122.36 CR	3 Nights	6.60%
NewBook Online	189	159	30	$33,542.00 CR	$177.47 CR	3 Nights	3.46%
Website	97	83	14	$18,177.55 CR	$187.40 CR	3 Nights	1.77%
Facebook	71	60	11	$11,335.00 CR	$159.65 CR	7 Nights	1.30%
WikiCamps	70	70	0	$8,212.05 CR	$117.32 CR	3 Nights	1.28%
Booking.com	34	20	14	$9,040.50 CR	$265.90 CR	3 Nights	0.62%
First Sun	18	18	0	$1,404.00 CR	$78.00 CR	7 Nights	0.33%
NSW CARAVAN & CAMPING DIRECTORY	15	14	1	$1,228.00 CR	$81.87 CR	3 Nights	0.27%
Trip Advisor	15	14	1	$2,704.00 CR	$180.27 CR	3 Nights	0.27%
Beyond Byron	14	14	0	$2,493.00 CR	$178.07 CR	3 Nights	0.25%
Road/Street Signs	11	10	1	$2,555.85 CR	$232.35 CR	6 Nights	0.20%
AAA TOURISM	6	3	3	$481.71 CR	$80.29 CR	6 Nights	0.11%
Tourist Information Office (Byron)	3	3	0	$215.00 CR	$71.67 CR	2 Nights	0.05%
NRMA EXPERIENCE NSW	1	1	0	$176.00 CR	$176.00 CR	2 Nights	0.01%
Total	**5451 Bookings**	**4871 Bookings**	**580 Bookings**	**$849,796.30 CR**	**$155.90 CR**	**3 Nights**	**100.00%**

BYRON SHIRE COUNCIL
STAFF REPORTS - INFRASTRUCTURE SERVICES 13.19

Statutory and Policy Compliance Implications

Current zoning of land – LEP 2014 – Zone RE 1 – Public Recreation

Suffolk Beachfront Holiday Park is currently located on DP 1023737 Lot 100. Zone RE 1 – Public Recreation.

Zone RE1 Public Recreation

1 Objectives of zone

- To enable land to be used for public open space or recreational purposes.
- To provide a range of recreational settings and activities and compatible land uses.
- To protect and enhance the natural environment for recreational purposes.

2 Permitted without consent

Environmental protection works

3 Permitted with consent

Boat launching ramps; Boat sheds; Camping grounds; Caravan parks; Child care centres; Community facilities; Emergency services facilities; Entertainment facilities; Environmental facilities; Flood mitigation works; Function centres; Horticulture; Information and education facilities; Jetties; Kiosks; Markets; Recreation areas; Recreation facilities (indoor); Recreation facilities (major); Recreation facilities (outdoor); Respite day care centres; Restaurants or cafes; Roads; Signage

4 Prohibited

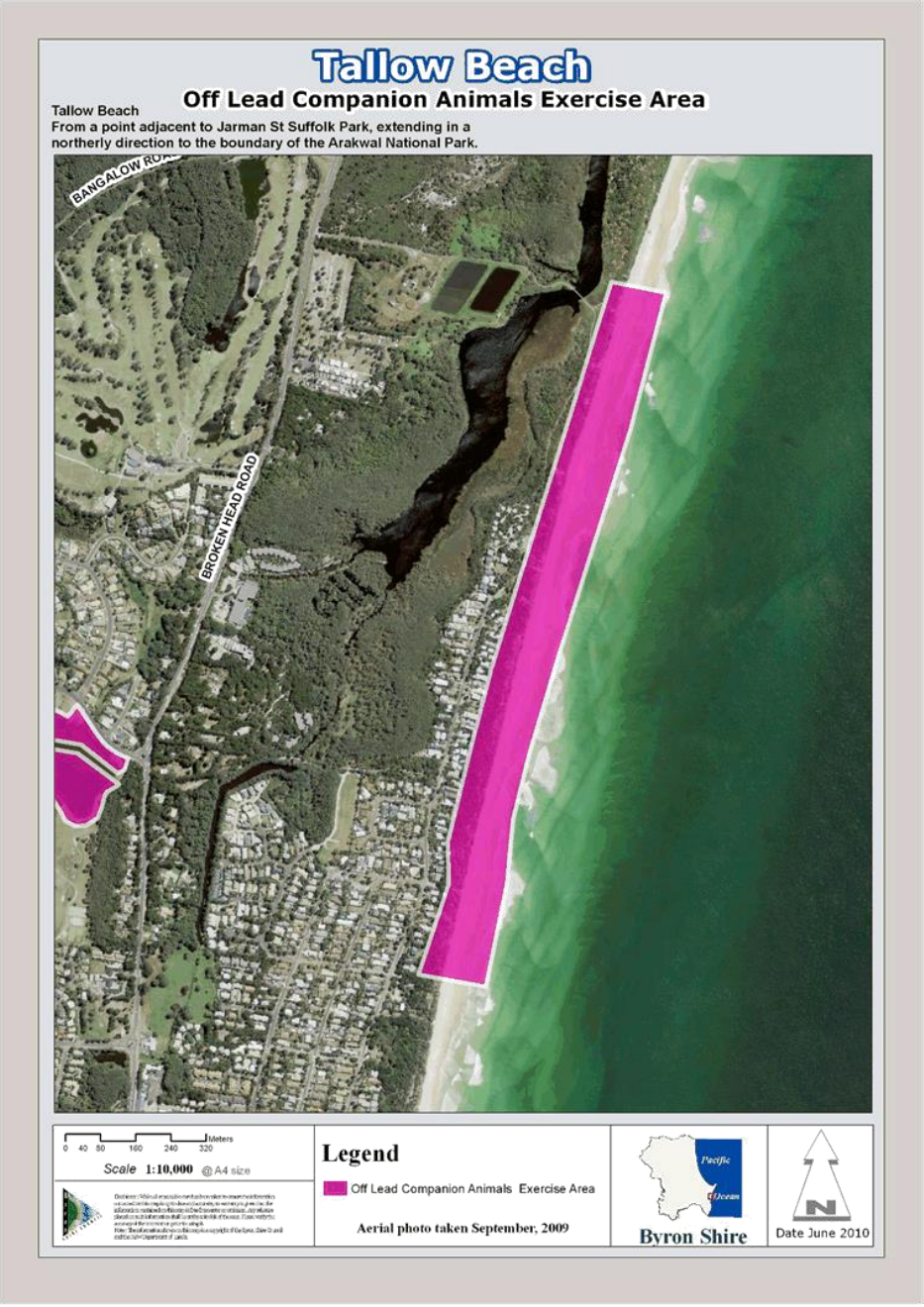
Any development not specified in item 2 or 3

Permanent Sites at the park have been reclassified as Operational Land recently. These sites are separate from the dog friendly sites.

Byron Shire Council Companion Animal Exercise Areas – Policy 5.31

Policy 5.31 adopted by Council in March 1994 and reviewed in October 2011 outlined off-lead exercise areas within Byron Shire. Tallow Beach shown in MAP 1 is the closest to Suffolk Beachfront Holiday Park. Tallow Beach off-lead exercise area is approximately 485 m from Suffolk Beachfront Holiday Park. This distance requires a short walk from Suffolk Beachfront Holiday Park.

MAP 1


Tallow Beach
Off Lead Companion Animals Exercise Area
Tallow Beach
From a point adjacent to Jarman St Suffolk Park, extending in a northerly direction to the boundary of the Arakwal National Park.
BANGALOW ROAD
BROKEN HEAD ROAD
Meters
0 40 80 160 240 320
Scale 1:10,000 @A4 size
Legend
Off Lead Companion Animals Exercise Area
Aerial photo taken September, 2009
Pacific Ocean
Byron Shire
N
Date June 2010

5

Benefits of Dog Friendly Suffolk Beachfront Holiday Park

- Allows Council's holiday park to remain competitive and in line with other holiday parks in and surrounding Suffolk Park area. Ferry Reserve at Brunswick Heads, Byron Holiday Park at Suffolk, North Coast Holiday Parks including Shaw's Bay in Ballina and Silver Sands at Evans Head have all converted to dog friendly periods and have reported an increase during off peak periods of approximately 60 to 70 %.
- Dog friendly availability offers extra service options for guests.
- Increases Council's revenue stream for this asset as shown below.
- Park Managers are able to manage this dog friendly status with no additional resources required from Council.
- Park location and relaxed nature support the dynamics of a dog friendly acceptance.

Non-benefits of Dog Friendly Suffolk Beachfront Holiday Park

- Continued and/or escalated negative feedback from park users and/or permanent residents and subsequent increased mitigation measures required by Park Managers in consultation with Council. Possible increase in costs associated with mitigation measures relevant to feedback.
- Forecasted revenue not as predicted.

Conclusion

Overall the dog friendly trial period was well received by both permanent residents and short term guests. There were instances where residents were unhappy with the effects of the dog friendly trial. Once mitigation measures outlined were strictly enforced many of these complaints were able to be minimised.

The separation of the dog friendly sites from the permanent resident sites proved to be a major factor in minimising this negative effect on permanent residents. Unfortunately, the managers of the park allowed dog friendly sites close to the residents for an interim period throughout the trial. This created permanent residents to become unsupportive of the dog friendly status and subsequently submitted unsupportive feedback.

Since then, Council has consulted with the park managers to promptly action the site separation preferences as discussed in the original trial. The mitigation measures outlined have had a positive impact on feedback received.

It is anticipated that there will never be 100% support of a Dog Friendly Park, however based on the feedback received and the success and failure points within the trial it can be concluded that there is general support from customers for the Park to become Dog Friendly.

Pet Friendly Park Rules

All Suffolk Beachfront Holiday Park guests have the right to enjoy the use of cabins, safari tents, onsite vans and sites for which a fee has been paid without undue interference from other guests & or their pets.

On the allowance of any guests' pets, owners must agree to certain rules and conditions as follows.

- The decision to allow a guest with a pet into the Park is at the Managers' & Onsite Managers' absolute discretion at all times
- Pets must be registered and have a current vaccination certificate (with these up to date) – required at check-in. Please contact your vet and have a copy faxed through if you do not have a copy on you.
- Pets need to be declared and signed in for upon arrival.
- Any animals seen in person or via CCTV footage to be chasing any wildlife or interfering with their nests, eggs or their young in anyway will be asked to leave immediately.
- Generally dogs above 20kgs will not be permitted, however larger dogs may be accepted on management discretion
- Pets must be kept on a lead at all times.
- An off-lead dog friendly beach is located 500 metres from the Park, however the beach in front of the park is not pet friendly and it is not permitted to walk any animals along this part of Tallow Beach at any time
- A map is provided along with these terms and conditions that explains all areas around the park that is out of bounds for your pet, please familiarise yourself with this and make sure you do not take your pet into prohibited areas
- Owners must clean up after their pets instantly at all times
- Pets are not allowed in any onsite park **accommodation** including cabins, safari tents and onsite caravan or any park facility at any time, they are only permitted in the guests own caravan, motorhome & campervan, or tent & must be on-lead at all times whilst outside in the park
- Pets must not be left alone at any time during the guest's stay
- Constant barking, howling or indulging in antisocial or destructive behaviour is not acceptable
- The Park washing machines, driers and laundry trough must not be used for washing pet bedding
- The Park laundry, amenities facilities, barbeque and camp kitchen areas are out of bounds to all pets at all times and under no circumstances may they be used for bathing pets, this also applies to the wash bays throughout the park, these are also not allowed to be used for washing of pets
- We are unable to permit dogs of a breed that may cause other guests to experience anxiety or fear of their safety
- Any dogs registered as a dangerous breed are expressly barred from entering the Park
- As ticks are found in northern NSW we recommend to use tick collars and check for ticks if pets have entered high grass
- Pets are not to be allowed to walk even on leash on the grassed area in front of permanent residents homes.
- Complaints from nearby residents and/or guests will be referred directly to the owners
- No refund will be payable due to early departure for any reason pertaining to your pet
- The Manager reserves the right to ask any guest with a pet to leave immediately if the above rules are not complied with or the pet is causing a nuisance
- These conditions are aimed at ensuring everyone has an enjoyable stay at our Park. Please consult the Managers for any further information you may require.
- As the pet owner you accept full responsibility for any personal injury or damage caused by your pet whilst in our Park. Guest(s) and pet owner(s) agree to indemnify and hold harmless Byron Shire Council, its managers, and their staff from all liability, loss and damage suffered as a result of the guest's pet. Furthermore, the guest(s) and pet owner(s) agree to solely accept all liability, financial or otherwise which may result in pet loss from disease, death, theft, fire, the running away of any pet or any other unavoidable circumstance. The Park reserves the right to charge the guest's account commensurate to the cost of such damages.

I confirm that I have read the above terms and conditions and agree that I will abide by these terms and conditions at all times during my stay at Suffolk Beachfront Holiday Park. I acknowledge that if I break any of the above terms and conditions, that I may be evicted from the park immediately and will forfeit all refunds.

Signed_____ Site No. _____

Dated _____ day of the month of _____ 2016

Owner's Name: _____

Pet's Name, Breed, Colour:_____