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Final

Trial and validation of Respondent-Driven Sampling as a cost-effective method for obtaining representative catch, effort, social and economic data from recreational fisheries

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Figures

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Abbreviations

CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAFF	Department of Agriculture, Forestry and Fisheries
DNRM	Department of Natural Resources and Mines
DPIPWE	Tasmanian Department of Primary Industries, Parks, Water and Environment
DSITIA	Department of Science, Information Technology and Innovation
EHP	Department of Environment and Heritage Protection
ESP	Ecosciences Precinct
Gile's SS	Gile's sequential sampling estimator
GU	Griffith University
RDS	Respondent driven sampling
RDS-A	RDS Analyst
SOE	State of the environment
SRS	Simple random sample
TRSF	Tasmanian recreational set-line fishery
UQ	University of Queensland
USC	University of the Sunshine Coast

Executive Summary

The objective of FRDC project 2012/021, "*Trial and validation of Respondent-Driven Sampling as a cost-effective method for obtaining representative catch, effort, social and economic data from recreational fisheries*" was to trial and validate the chain referral sampling method, Respondent Driven Sampling (RDS), for obtaining representative data from specialised 'hard-to-reach' components of recreational fisheries. This project aimed to test this new method by undertaking a RDS survey with a population of fishers who were part of a complete licence list frame. The characteristics of the sample (e.g. age, gender) from the RDS survey would then be compared to another survey collected via random stratified sampling drawn from the licence list frame. This would allow comparison of the results between methods to determine if the RDS survey can produce a representative sample of the population.

Telephone surveys have long been regarded as a cost-effective method for large-scale population sampling due to most households owning a landline telephone and being listed in a telephone directory (e.g. White Pages). However, in recent years, a decline in landline registration, increasing exclusive use of landlines for internet connections, and changes in population demography has led to a decline in the representativeness of the landline sampling frame on the overall population. In addition, with a limited number of recreational fisheries requiring a licence—many of which also have various exemptions— a secondary list-sampling frame is not always available to researchers to select a representative sample of fishers for a survey and hence probability-based sampling can be costly. These factors contribute to a degradation of the ability of scientists to yield a representative sample from the population via direct telephone polling, and highlight a need to explore new methods for more effective sampling of recreational fisheries. A trial of the RDS method is needed as it may be one of the few methods that can cost-effectively attain reliable data from specialised fisheries that lack a complete licence list frame of participants. It may also be particularly useful in situations where the participants are too rare within the wider population to be sampled in sufficient numbers using traditional probability-based survey methods, such as general population telephones surveys.

RDS is a peer-driven recruitment process initiated by a small number (4-6) of members, or 'seeds', from the target population who each complete a questionnaire. On completion, each person is given a small 'initial reward' and 2-3 uniquely coded coupons to pass to eligible peers. The person is instructed they will receive a 'secondary reward' if their peers recruit to the survey. When each peer is recruited and completes a questionnaire, they are also given two coupons to pass to other eligible peers. This chain-referral process continues and produces rapidly expanding recruitment chains until the sample reaches 'equilibrium', whereby the proportion of population characteristics (e.g. gender, age) no longer change with further sampling.

The Tasmanian government issues a number of specialised recreational fishing licences without exemptions, which provided an opportunity to trial RDS and assess its efficacy against the known population of licence holders. These include the Tasmanian recreational set-line and rock lobster fisheries. The set line fishery is specialised in terms of the species targeted and the gear used (mainly longline). The number of licence holders is around 4000. The Tasmanian recreational rock lobster fishery again has no licence exception but is larger with around 18,000 licences issued per year. The fishery is based on two species, southern rock lobster and eastern rock lobster, and has definitive sub-fisheries where participants purchase licence endorsements for collection by pots, rings or by hand while using SCUBA equipment or free diving.

We used the RDS method to study three populations. First, we undertook a pilot survey of a staff population at the Ecosciences Precinct (ESP), Brisbane to optimise sampling and operational procedures and validate the mechanics of the RDS method. ESP is a government-owned building housing 827 staff at the time of the survey representing CSIRO, four government departments, and three universities. This urban and socially cohesive population experienced a range of hardships during a forced re-location to ESP from various locations around Brisbane. As such, the pilot survey of their experiences during the relocation resulted in a high level of engagement in the process. The mechanics of the survey performed as planned, with 'waves' of respondents being recruited from an initial seeding of 7 individuals. In total, 394

coupons were issued and 197 interviews completed. All but 10 of the respondents originated from the one seed.

Subsequently, two field trials of RDS within the Tasmanian recreational set-line fishery and rock lobster fishery were conducted. As a precursor to these trials, a workshop with recreational fisheries representatives was undertaken to explore the logistical details associated with implementing an RDS survey. The workshop was attended by international RDS experts, fisheries scientists, statisticians, a fishery manager, and recreational fishing group representatives. One key recommendation from the workshop was to undertake focus group meetings with set-line fishers to seek feedback on specific aspects of the survey method (e.g., incentive amount and type), which were undertaken in Devonport and Hobart.

The survey of Tasmanian recreational set-line fishers was conducted between November 2014 and April 2015. We developed a survey tool and database "RDS-Recfish", for implementing RDS surveys, managing coupons and incentives. A prototype of this tool was trialled at the focus group workshops and refined following feedback on the questionnaire and survey structure. RDS-Recfish was then used to implement the first RDS survey. Initially, total of six seeds were recruited to start the survey, based on their geographic location and fishing club membership status. However, long sequence chains of RDS recruits did not occur from these seeds. From 27 recruitment coupons that were circulated by the seeds, only three fishers were recruited. A follow-up survey indicated seeds had no issues distributing coupons to other fishers, however many noted 'obvious scepticism' when trying to explain the research objectives to potential recruits.

The second field trial of RDS involved the Tasmanian recreational rock lobster fishery. Based on the findings from our set-line study, we adapted our methods to increase the likelihood of developing long recruitment chains that expanded into the general population of fishers. This involved dramatically expanding the number of initial seeds to 41 fishers over multiple waves of recruitment, seeding across potential barriers to recruitment—namely geography and gear type—and undertaking personal briefings of seeds and a follow up survey to better understand psychological aspects of the recruitment process. While our follow up survey indicated that most seeds had passed on their coupons, only five eligible fishers were recruited from the 135 coupons distributed.

As part of the survey we collected economic data from the rock lobster fisher seeds. This indicated that the recreational take of lobsters is highly valued, grossly exceeding the market price, with fishers spending hundreds to thousands of dollars for each landed animal. However, as this data may not be representative it should be only considered as an interesting aside to the main methods assessment focus of the study.

While there appeared to be no issue with distribution of the coupons by the seeds the following key mechanic of the method, which required the coupon recruited fisher to make a phone call on their own initiative back to the researcher, rarely occurred. A level of psychological inertia was not overcome by these fishers, as they were not sufficiency motivated to make this call. We think that in additional to the generous monetary reward offered, another strong non-monetary incentive may also have been required, such as was the case in the ESP study, to improve the survey response rate.

There has been widespread success of RDS in a range of highly connected hard-to-reach populations (e.g., illicit drug users) in densely populated urban settings. We think that in addition to fishers not be motivated by the solidarity of stigmatisation - they are after all participating in a legal and licenced activity with strong cultural roots – potentially their low frequency of social interactions may have been a further impediment to their motivation to make contact with the researcher. In other RDS research including our office block EPS study close, repeated close social interactions with seeds can provides 'peer pressure' or 'group-mediated social control' to encourage participation in the survey.

Another potential impediment was the choice of contact technology. In addition to declines in land-line use there has been a further recent shift towards text based communication by the general population. The survey was dependent on voice phone calls, and paper coupons. While other methods, such as SMS, could be used to distribute coupons codes, fishers still needed to ring a phone number and leave a voice message. An option to establish communication via various on-line text forms (i.e. social media) may have improved the response.

A further possibility for the failure, particularly of the set line case study, was scepticism among fishers that the use of research survey data will be used as a justification for implementing management measures to limit their fishing opportunities. Such negative attitudes towards research have the potential to spread through the social networks of fishers to inhibit RDS recruitment. However, in the rock lobster fisher study, there was strong support for the science aims of the work both by seeds and during the follow up survey.

Finally, we were not able to test the representativeness of the data as we could not get the mechanics of the RDS method to work for our two case study fisheries. However a simulation of the RDS methods suggested that differential recruitment by seeds of fishers can lead to substantial bias and this bias cannot be detected from the RDS sample alone.

Despite the comprehensive preparation and collective efforts of our team, international RDS experts, recreational fisheries survey design experts, fishery managers and recreational fishing advisory members, RDS did not function as anticipated in two distinct recreational fisheries trials. Through the field trials, the simple act of calling the project's freecall telephone number appeared to present the greatest impediment to recruitment from the many fishers who accepted a coupon from their peers to participate in the surveys. Our method may not have also accounted for other specific psycho-social factors that created impediments to recruitment. Further work focusing on the motivations of fishers to participate in research surveys, their preferred communication technology, their psychological responses to incentive types, and the social inertia that needs to be overcome to recruit one's peers, may guide researchers to continue to adapt interview methods for recreational fisheries research.

Recommendations

Without a highly motivated population of socially closely connected fishers, RDS does not appear to be cost-effective method for obtaining representative catch, effort, social and economic data from recreational fisheries.

Future trials of similar methods for surveying recreational fisheries may consider using other types of survey administration that do not require direct voice contact with staff (e.g. self-administered surveys online via social media) may result in more recruitment. However, such methods need careful consideration and testing prior to use since they may introduce a suite of poorly understood sampling biases that compromise the representativeness of the sample.

A repeat of previous economic surveys of the recreational rock lobster fishery, based on a representative sample of the licence frame, could provide an interesting assessment of high value placed on landing lobsters.

Keywords

Chain referral sampling; hidden population; Tasmanian recreational set-line fishery; Tasmanian recreational rock lobster fishery; Southern Rock Lobster

Introduction

1.1 Sampling recreational fisheries

Recreational fishing is a popular activity both globally and especially in Australia (Arlinghaus 2006; Cooke and Cowx 2004a; Henry and Lyle 2003; Lewin et al. 2006) and for many species, the recreational catch exceeds the commercial catch (Giri and Hall 2015; Lyle et al. 2014b; Zischke et al. 2012). One outcome of the last State of the Environment (SOE) report and recent state-wide recreational fishery assessments was the suggestion that components of the Australian recreational fishing sector are moving further offshore in their pursuit of fishing opportunities (Evans et al. 2017). Rapid improvements and cost reduction of fishing technologies may have also improved both the experience of fishers and the effectiveness of their fishing effort. For example, in NSW between 2000/01 and 2013/14 the number of boats equipped with an echo sounder increased by over 50% and those with GPS more than tripled. Targeted species included traditional offshore pelagic gamefish such as billfish and tunas but also deeper demersal and shelf species such as blue-eye trevalla, emperors, snappers and cods (Lowry and Murphy 2003; Moore et al. 2015 ; Morton and Lyle 2004) and this may be leading to inter-sector conflict (Goodyear 2007). For effective management of fishery stocks and to ensure equitable resource allocation among sharing sectors, a better understanding of catch and the structure and social-economic factors of recreational fisheries. Unfortunately, reliable large-scale recreational fisheries data is sparse, with no national survey conducted since 2001 (Henry and Lyle 2003).

Unlike compulsory self-reporting of catch and effort by most commercial fisheries, assessments of open access recreational fisheries require sampling (McCluskey and Lewison 2008; Smallwood et al. 2012). Surveys of recreational fisheries utilised a diverse range of sampling techniques, each developed to target specific aspects of a recreational fishery, such as catch and effort. For large-scale surveys, off-site telephone surveys based on random stratified sampling of White Pages listings have been commonly employed due to their cost effectiveness, regional focus and scalability (Pollock et al. 1994). However, the efficacy of telephone-based approaches are rapidly diminishing due to changes in telecommunication use. In 2016, only 68% of Australian households were listed in the White Pages, with a steady decline of 2-4% annually (ACMA 2016). Because of a decrease use of land-line phones, and their strong demographic skew towards older and wealthier customers, phone interviews increasingly require weighting and bias corrections to collect representative samples (Badcock et al. 2016; Blumberg and Luke 2009; Teixeira et al. 2016).

Unfortunately, obtaining representative data from specialised recreational fisheries (e.g. gamefish fisheries) using traditional methods is cost-prohibitive and often ineffective because these specialised fisheries: 1) lack a complete sampling frame to recruit fishers to surveys, 2) are comprised of fishers who are too rare to intercept in the wider community, and 3) are spatially and/or temporally diffuse. Given the non-licenced nature of most recreational fishing, as well as the relatively small size of many specialised fisheries (e.g. game fisheries), the recreational fishing population can be considered as ‘hard to reach’, therefore, alternative cost-effective methods are required.

1.2 Surveying hard to reach populations

Many scientific disciplines researchers rely on the acquisition of self-reported information from human subjects to better understand particular population characteristics, such the prevalence of specific diseases. Because a census of the population is often not feasible practical or cost-effective, due to the common absence of complete list frames of participants, a sample of subjects that is representative of the target population is needed to make inferences about the characteristics of the wider population. Unfortunately, obtaining a random or representative sample from a population using probabilistic sampling is often difficult due to the biases introduced by the sampling tool (i.e. “sampling bias”) or the behavioural responses by humans to the sampling tool (i.e. “non-sampling bias”). Consequently,

any uncorrected bias can skew the direction and magnitude of the characteristic being measured (e.g. % infected by HIV) when expanding the value to represent the wider population.

Non-sampling biases can be most difficult to understand, quantify and correct, since they may relate to psychological or emotional factors such as the decision of a person to accept or decline an invitation to participate in a survey, or rounding numbers when ask to report large numbers. However, with refinements to the questionnaires these biases can be reduced. Sampling biases are more easily understood, because it involves the process by which the samples are attained, rather than the aquisition of self-reported data once a subject has been recruited. Understanding a potential bias does not necessarily make it easier to correct, but it allows the researcher to better understand the potential direction and magnitude of the bias and to refine a sampling regime in future surveys.

Human populations have been sampled using a range of survey methods depending on the characteristics of the population gleaned from formative research and the resources available. Telephone surveys have long been regarded as a cost-effective method for large-scale population sampling due to most households owning a landline telephone and being listed in a telephone directory. However, in recent years, landline telephone list frames have become decreasingly representative of the population. This is primarily due to increases in: refusal rates (or 'hang ups') of unsolicited calls, the number of unlisted numbers, the exclusive use of landline numbers for internet use and an ageing demographic of users owing to a general shift towards exclusive use of mobile telephones. All of these factors contribute to a degradation of the ability of scientists to yield a representative sample from the population via direct telephone polling.

Researchers in the health sciences often need to understand health issues that are relevant at the population level, such the prevalence of socially sensitive diseases such as HIV. However, to understand prevalence at the population level, researchers are often faced with the difficult prospect of needing to sample specific components of the population, which often exist as hidden, rare, hard-to-reach, or stigmatised communities within the general public, such as people who inject drugs (PWIDs), men who have sex with men (MSMs), and female sex workers (FSWs). Such populations are hard-to-reach because they are rare within the wider community, lack a complete list frame, and engage in illegal, stigmatised or socially unacceptable activities. As a result, traditional survey methods are often ineffective or cost-prohibitive for sampling these populations. Therefore, alternative cost-effective approaches have been developed.

Respondent-Driven Sampling (RDS) was first introduced by Heckathorn (1997) as a means for surveying hard-to-reach populations by capitalising on the social connectivity between individuals who share similar attitudes, traits, or activities. RDS is a form of peer-driven chain-referral sampling that was designed by epidemiologists to obtain and analyse probability samples from 'hard-to-reach', hidden or stigmatised populations, such as PWID, FSW, and the homeless (Heckathorn 1997).

The application of RDS to hard-to-reach populations has increased dramatically over the past five years. Although RDS has been used in a variety of applications in over 120 studies spanning 30 countries (Abdul-Quader and others 2006), there have been very few instances where population prevalence estimates from RDS samples or estimators have been compared to true populations (White and others 2012). The simple explanation for this is that if a census of a population could be achieved, by definition it would not qualify as being 'hard-to-reach'.

Therefore, the primary objective of the this project was to attempt to validate RDS by comparing the population prevalence estimates derived by RDS surveys for specialised recreational fishing populations that have complete list fames.

1.3 Description of RDS

RDS is a non-random chain-referral sampling method that works by an initial set of subjects from the target population—or "seeds"—receiving a small number (e.g. 2-3) of uniquely coded coupons to pass

on to eligible peers from the target population. Subjects receiving a coupon contact the researcher, complete a survey and serve as the first recruitment 'wave'. These new recruits are then given coupons to recruit further subjects, and so on, creating rapidly expanding recruitment chains. Sampling continues until "equilibrium" or "saturation" is reached, whereby the proportion of predetermined groups within the population (e.g. males and females) varies by less than 2% in the overall sample regardless of how many further waves are recruited (Heckathorn 1997; Salganik and Heckathorn 2004). It is at this point, after sample correction using an appropriate estimator, that the characteristics of the sample is presumed to be representative of the target population. Because respondents are responsible for recruiting eligible peers, a sample can be cost-effectively obtained from populations that are hidden, rare, stigmatised or only accessible by insiders (Wejnert 2009).

The efficacy of RDS can be attributed to its dual-incentive recruitment process that creates group-mediated social control—a form of peer pressure—strengthened by the desire of recruiters to redeem their secondary reward (Heckathorn 1990). Therefore, non-response is often very low and also not skewed towards more affluent peers, since subjects who have little interest is recompense often participate as a favour to a peer (Magnani et al. 2005).

RDS builds on the principles of snowball sampling (Goodman 1961) but the recruitment process is modelled to compensate for the non-random sampling of subjects and the subsequent biases introduced (Heckathorn 1997, 2002). In particular, the proportion of the sample representing different groups within the target population (e.g. males vs. females) are weighted to account for 'in-group affiliation' bias, created by the tendency of subjects to recruit peers with characteristics similar to themselves (Heckathorn 2002).

The underlying model of RDS is a stochastic first order "regular" Markov process where only a limited number of states can be assumed. This is a memory-less process whereby the patterns of recruitment are dependent only on the characteristics of the recruiter, and not the recruiter's recruiter. Therefore, recruitment is ergodic, that is, the process can move between states, any state can recur, and there is a zero probability that any single state will not recur (Heckathorn 2002).

The RDS coupon system allows the relationships between a recruiter and their recruits to be mapped. This allows any 'within-group affiliation' bias to be corrected by comparing the proportion of each group in the final sample (e.g. males versus females) to the group membership of seed subjects to assess whether recruitment was independent.

RDS also overcomes 'differential recruitment' bias, whereby one group (e.g. males) may recruit a disproportionally high number of subjects from a particular group (e.g. females) that contain individuals having larger network sizes (or "degree"). This group therefore, has a higher probability of being recruited, and thus the potential to be overrepresented in the overall sample. By obtaining each subject's estimated degree—the total number of eligible peers that could be chosen to receive an RDS coupon—the ratio of subjects belonging to each group can be weighted according to their relative probability of inclusion.

Understanding how within-group and differential recruitment biases affect recruitment dynamics is important in planning RDS surveys for two interrelated reasons. First, it allows the researcher to develop a sampling strategy that is most likely to develop robust recruitment chains that recruit a diversity of subjects, which can largely be controlled by selection of suitable seeds. This will then allow equilibrium to be reached more quickly to, and thus minimise survey costs.

1.4 Assumptions of RDS

Numerous assumptions about the RDS model and recruitment process applied to the RDS trials in this project. The underlying assumptions of RDS are that:

i) all individuals in the target population are in some way socially connected and have a non-zero probability of recruitment,

ii) a dyadic relationship exists between peers, that is, the membership of an individual in the target population is known by their peers and vice versa,
iii) recruitment of peers is random and non-preferential,
iv) recruits are selected with probability proportional to their degree size,
v) respondents can accurately recall their degree size, and
vi) respondents participate only once and are not duplicated or impersonated (Heckathorn et al. 2001).

Objectives

The primary objective of FRDC project 2012/021, "*Trial and validation of Respondent-Driven Sampling as a cost-effective method for obtaining representative catch, effort, social and economic data from recreational fisheries*" was to trial and validate the chain referral sampling method, Respondent Driven Sampling (RDS), for obtaining representative data from specialised 'hard-to-reach' components of recreational fisheries.

First, we aimed to conduct a pilot study to validate the RDS method, and to optimise sampling and operational procedure. In order to run a scientifically valid yet inexpensive survey, RDS was used as the sampling method to undertake a simple lifestyle well-being and transportation survey of staff at the Ecosciences Precinct, Brisbane, a government-owned building having a known population size of 827 people at the time of the survey.

This project also aimed to field test RDS on the Tasmanian recreational set-line fishery. Specifically, this project aimed to:

1) Conduct focus group meeting with international RDS experts, fisheries scientists, statisticians, a fishery manager, and recreational fishing group representatives to explore logistical details of RDS and design mechanism of RDS survey for recreational fisher,

2) Implement RDS survey on the Tasmanian recreational set-line fishery, and

3) Compare population characteristics derived from the RDS survey with that of the known population via a telephone survey of licence holders.

With limited number of response from the initial RDS field trial on the Tasmanian recreational set-line fishery, this project was re-scoped in early 2016 for a second field trial in 2017. The Tasmanian recreational rock lobster fishery was selected as it has similar properties as the Tasmanian recreational set-line fishery (licenced) but had a higher participation rate. The aim was to conduct a second field trial of RDS survey on a recreational fishery and compare the result with the known licence frame and pairwise random telephone survey.

Method

3.1 ESP staff well-being pilot survey

3.1.1 Data and assumptions for developing a sample of ESP staff

To trial the efficacy of RDS against a known population it is necessary to be able to define the population characteristics (e.g. number of staff employed by each organisation within ESP, gender ratio). In order to engage the population, it is necessary to devise a research subject matter that is relevant to the entire population. In other words, we wanted to minimise the potential for non-response or refusal to participate in the study based on the study subject matter alone.

ESP was built as a collaboration hub for various research, management and policy agencies from state government, CSIRO, and local universities that were relocated from various sites across the city of Brisbane, Australia. The building consists of three 'towers' (A, B and C) and generally two wings (East and West) within each tower. The building has five levels containing offices (G, L1, L2, L3, L4) and three 'basement' levels (B1, B2 and B3), whereby only a very small number of offices exist on B1 and B3. In total there are a total of 18 office strata within the building.

ESP was first occupied by government employees in October 2010. As a result of relocating employees from various distances around Brisbane and further afield, there was inevitable disruption of their lifestyles. Because ESP was designed without car parking facilities for employees, they were required to rely on other forms of transportation to ESP, such as public train and bus transport that had routes altered to accommodate ESP staff. This disruption has long been a discussion point for ESP staff, as they come to terms with a lifestyle change that affected commuting times and physical well-being. Given that the relocation to ESP affected all staff in some way, we decided to make this the subject of an RDS survey to later compare with the true population of ESP from census data.

The "ESP Staff Well-being Survey" was a 7-10 minute survey administered by telephone. The survey first collected general demographic information about the respondent that would serve as the main characteristics for comparison with the true population (employer, level of the building, and gender). These were followed by more specific questions relating to the change in staff's commuting mode, duration and lifestyle since moving from their previous place of employment, but data from this part of the survey will not be presented as it is not relevant to the recruitment dynamics of the RDS trial. The survey then gathered information on the degree of each respondent; a fundamental requirement for analysing an RDS sample. Two different questions were asked to estimate degree, since "how many people do you know?" can have a very different meaning to "how many people would you consider passing a coupon to?" (see 3.1.3).

3.1.2 Seeds and recruitment process

The recruitment process was initiated with the selection of seed respondents who would serve to recruit the first 'wave' of recruits from the target population. In contrast to snowball sampling (Goodman 1961), seeds do not need to be randomly selected from the target population since the composition of subjects at equilibrium in an RDS survey is independent of the composition of seeds (Heckathorn 2002). Therefore, by choosing well-connected 'super seeds' or 'sociometric stars' who represent the breadth of key characteristics of the population, there is a greater probability of developing long, robust recruitment chains that penetrate deep into the sociometrics of the population, and therefore reaching equilibrium more rapidly for key population characteristics (e.g. employer, gender) (Wejnert and Heckathorn 2011).

The recruitment of ESP staff was initiated by selecting seven 'seed' respondents who represented different agencies, were located on different levels of the building, and had large social networks to maximise the potential for progressing recruitment beyond the first wave. Seeds, and subsequent

recruits, were asked to complete the survey and to distribute two uniquely-coded paper coupons (Figure 3.1) to recruit other eligible ESP staff. Each respondent was informed that they would receive a voucher for a free standard beverage (e.g. coffee, tea, or soft drink valued at around AUD$4) at ESP's only café (Figure 3.2). They were also informed they would receive a second free beverage voucher if the recipients of both coupons successfully recruited to the survey. Given the close proximity of staff to each other, an expiry date of 7-10 days from the survey date was deemed sufficient and was written on each coupon. In some cases where respondents indicated they would be away from ESP for business or personal travel, we extended the expiry period for up to 3 weeks.

In order to assess the efficacy of RDS, it needed to be capable of sampling from the same population for which census data were available. Therefore, explicit eligibility criteria were explained verbally at the end of each interview and given to each respondent in written form with their coupons and reward voucher. It was explained that if the peers whom they choose to give a coupon are ineligible or do not complete the survey, the second reward would not be granted. To be eligible for the survey each respondent must:

1) have a direct ESP phone number assigned to their name (meaning the person has an allocated workstation on the staff manifest),
2) not have participated in the survey previously,
3) be at least 18 years of age,
4) know their recruiter personally.

Recipients of a coupon were directed by their recruiter to call a toll-free telephone number printed on the coupon, which had a dedicated message service informing respondents to leave their name, coupon code, and a preferred time and telephone number to be contacted. Project staff would check the message service every 1-2 hours and call respondents back at the appropriate time. A maximum of fifteen call back attempts were made before removing the subject from the sample, which only occurred in one instance.

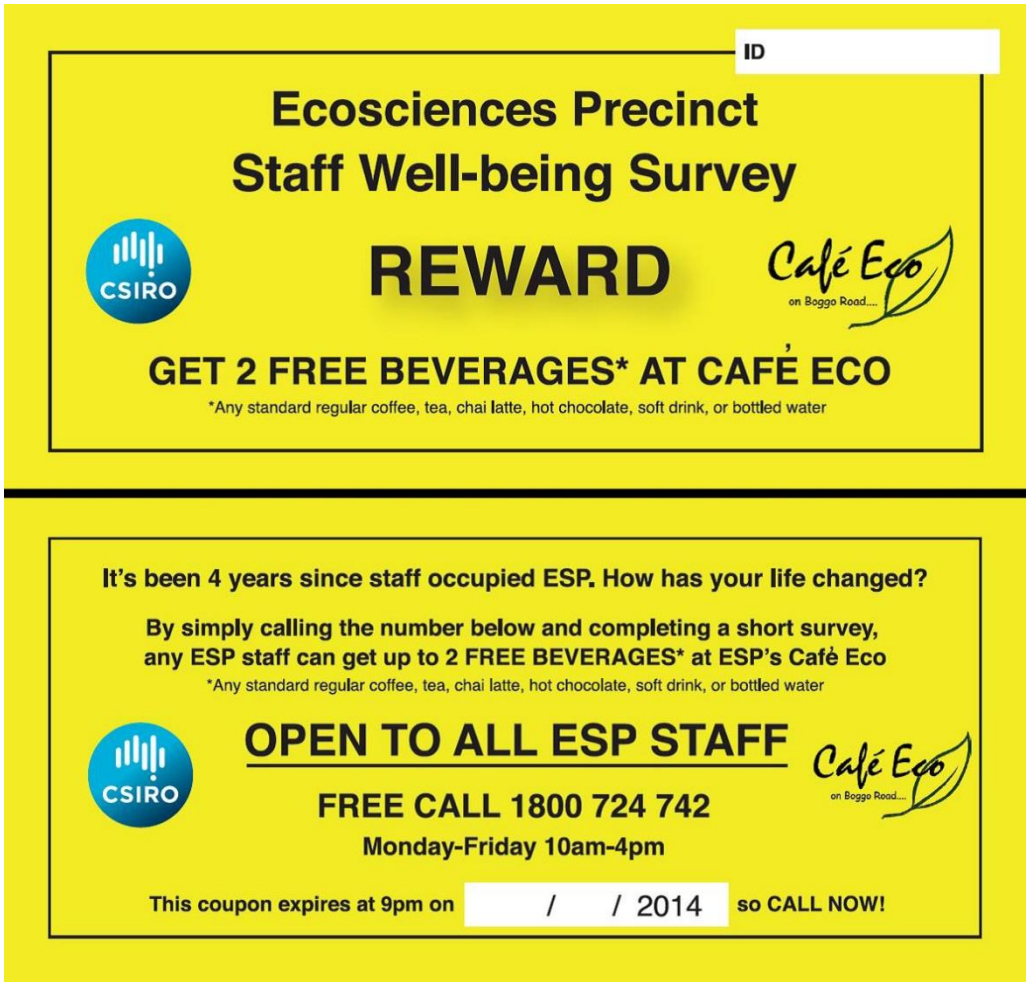

Figure 3.1: Illustrations of the front (top) and back (bottom) of the yellow recruitment coupons issued to respondents in the Ecosciences Precinct Staff Well-being survey. Respondents were instructed to pass two coupons to eligible peers to recruit them to the survey.

Figure 3.2: Illustration of the reward voucher given to respondents for participating in the Ecosciences Precinct Staff Well-being survey and for recruiting two eligible ESP staff to the survey.

3.1.3 Estimation of personal degree

One of the key assumptions of RDS is that each respondent can accurately estimate the number of eligible peers in their network. Bengtsson and Thorson (2010) found that prevalence estimates of a particular population characteristic will be underestimated if degree questions relate to how many eligible people a respondent knows, rather than how many people they would actually consider passing a coupon to.

In this study, two measures of network size were used to understand the social connectivity of ESP staff, and to also be used as a weighting factor to correct for differential recruitment bias before analysing the RDS data (Heckathorn, 2007). Respondents were first asked "*If you were given an unlimited number of coupons to give to ESP staff that you know personally, how many people would you consider giving a coupon to if you had 6 months to distribute them?*" The term "*knowing someone*" was explained to each respondent as being someone they know by their full name or someone they know well enough to initiate and hold a personal conversation with in person or by electronic correspondence. For example, "*Did you and your wife Mary enjoy the wedding you attended in Melbourne last month?*" It was explained that the relationship also had to be reciprocal, that is, the respondent knows a particular ESP staff member, and the respondent is reasonably confident that the ESP staff member knows them. This question allows respondents to estimate the total number of people a respondent believes they know, which likely includes people whom they may not know well or interact with infrequently. We regard this as the "extended network size" estimate.

People often unknowingly overestimate their popularity within social networks due to egocentric tendencies that allow them to believe they are well liked by their peers. However, when honing a question to reduce cogitative biases caused by one's own perceptions, more accurate representations of social relationships can be understood. Therefore, we followed the extended network size question with "*How many of these people would you realistically consider giving a coupon to, and think they would consider accepting the coupon from you, within the next 4 weeks?*" This question focuses the respondent's response within a specified time frame, which aids in excluding infrequent, and most likely weaker, social ties. This was also used to reduce various egocentric biases – such as egocentrism and the "false consensus effect" – a form of perceptual distortion commonly evoked by people assuming consensus based on their own attitudes, beliefs and behaviours (Mullen, 1983; Alicke and Largo, 1995). In other words, by giving a respondent's peers the 'power' to determine the existence and relative strength of a social tie (i.e. by deciding to accept a coupon or not), a more realistic estimate of a respondent's personal network size can be obtained. We refer to this as the "immediate network size" estimate.

3.1.4 Questionnaire design

The survey questionnaire was designed to minimise the time burden on respondents and be completed in 7-10 min when administered by trained interviewers by telephone. Before beginning each questionnaire (RDS and online), respondents were informed that the survey had been approved by the CSIRO Human Ethics Committee (Application 068/14); how the data would be managed and used; and asked to provide consent to proceed. After providing consent, the respondent was asked questions that collected general demographic information (e.g. employer, level of the building, gender). More specific questions followed, relating to the change in staff's commuting mode and duration, and daily physical exercise activity since moving from their previous place of employment. The survey then gathered information on the social network size of each respondent and their involvement with ESP social and sporting groups.

3.1.4 Analysis of the RDS sample

On completion of the RDS survey, data were analysed using RDS Analyst (RDS-A) software. In recent years there have been several estimators developed that each claim to address the shortcomings

of other estimators. However, to our knowledge, none of the estimators have be validated against a real population, and collectively, the estimators have not been compared simultaneously against a real population. Because census data for ESP staff was available, it allowed us to make statistical comparisons regarding the performance of each RDS estimator.

The performance of three estimators was compared by estimating the population prevalence of the three population characters using the RDS sample data. The first estimator was the crude or naive estimator, which uses only the unadjusted RDS sample to produce population prevalence estimates for each character. The RDS-II, or the Volz-Heckathorn estimator (Volz and Heckathorn 2008), was the second estimator chosen as it is the most widely used in RDS studies because it makes more realistic assumptions about differential recruitment than the original RDS-I, or Salganik-Heckathorn estimator (Salganik and Heckathorn 2004). Third, we chose the recently developed Gile's Sequential Sampling (SS) estimator (Gile 2011), as it has been specifically designed to be implemented in surveys where the sampling fraction is more than 30% of the population (Tyldum and Johnston 2014). The census data also allowed us to generate a simple random sample (SRS) of the population to compare the RDS estimators to.

3.1.5 Homophily

Understanding the extent to which a particular group recruits from within or outside that group—known as 'homophily'—is important for minimising within-group affiliation bias. Using the population characteristic of gender, population homophily can be defined as the ratio of the expected number of male-female couples to the expected number of same-gender couples. Therefore, larger population homophily values indicate more homophily on gender prevalence. In other words, a homophily value of 1 means the couples are random with respect to gender. A value of 2 means there twice as many same-gender couples as we would expect if there was no homophily in the population. As an example, if the population homophily for gender is 0.75, there are 25% more male-female couples than expected due to chance, indicating there is actually heterophily on gender within the population. If the population homophily on gender is 1.1, there are 10% more same-gender couples than expected due to chance, and therefore, only modest homophily on gender. Convergence of population characteristics can still be reached if recruitment is highly homophilic or heterophilic, but the sample is less likely to be representative of the true population.

3.1.6 Population census data for ESP staff

Due to government health and safety policy and legislation, up-to-date staff manifests are required to be held by each agency occupying ESP. Together, these comprise a complete census of the ESP population. For each organisation, staff manifests included surname and given name, employer, building level and wing, gender, telephone number and email address of each staff member. To align the actual population with the eligibility criteria of the RDS respondents, we omitted from the census staff who:

i) did not have a direct ESP landline telephone number assigned to their name. Staff with only a listed cellular phone number were also omitted since they often utilised a number of work sites or were on short-term specialised work contracts,
ii) did not have a designated workstation in the building, which is often the case with temporary or short-term contract workers, or
iii) were noted to be on leave for a period of more than 3 months or on a secondment during the study period, and were therefore out of frame. A total of six staff was omitted from the census.

3.1.7 Effects of non-response on RDS population proportion estimates

Since the objective of RDS is to attain a sample that can be weighted to produce representative population estimates, it is important to determine whether the characteristics of non-respondents differ

to those of the respondents, which may bias prevalence estimates. Non-response in RDS surveys can be separated into three components; refusals ("I do not wish to participate"), non-issue of coupons ("I will accept a coupon and will complete a questionnaire, but I don't wish to recruit others"), and non-response ("I will accept a coupon, but will decide later if I wish to participate").

Refusals constitute the decision by an eligible subject to decline acceptance of a coupon offered to them by a survey respondent. Because this is a special case of non-response, refusals will be addressed separately in section 4.1.10.

Non-issue of coupons can be defined as the failure of a survey respondent—who has completed the interview and received their reward—to distribute one or more coupons to an eligible subject. There may be a range of reasons why coupons are not issued such as; coupon expiring before attempting to distribute them, insufficient/undesirable secondary incentive, did not know an eligible subject to approach, or their eligible peers had already participated in the survey. It is important to know how many coupons fail to be issued to better understand the extent to which coupon recipients decide not to participate.

True non-response is the acceptance of a coupon by an eligible peer who fails to participate in interview. The unrelinquished coupon therefore appears in a database as the respondent failing to recruit an eligible subject, rather than an eligible subject failing to participate. There may be a range of reasons why coupon recipients do not participate such as; later deciding the study was not as interesting as first thought, coupon expiring before being able to contact the researcher—often the fault of the recruiter distributing the coupon too close to the expiry date, insufficient or undesirable initial incentive. It is important to know the extent of non-response to determine if the sample is affected by non-response bias. Furthermore, it's useful to better understand why coupon recipients decided not to participate so that measures can be put into place in future surveys to increase the response rate, such as increasing the initial incentive.

Without violating the confidentiality of every subject who received a coupon, it is generally not possible to survey non-respondents in RDS surveys. However, by asking respondents about the recipients of their coupons, it is possible to build a general demographic profile of each coupon recipient with respect to the key population characteristics being measured in the study (e.g. employer, gender and building level). The characteristics of the non-respondents can then be compared with the characteristics of the respondents to determine is the sample is likely to have been affected by non-response bias.

In a follow-up survey of respondents, they were asked to provide information on each of the two coupons they were issued. First they were asked if the first coupon was attempted to be distributed, and if so, if it accepted by someone, and how many days it took to be accepted. If the coupon was accepted, the respondent was asked—without revealing the identity of their peers—to reveal the employer, gender and building level of the coupon recipient. The same process was followed for the second coupon. During this questioning, we were also able to determine if one or both coupons were not distributed, either because they were not accepted by a peer, or if the respondent did not attempt to distribute them. This allowed us to identify non-issued coupons and subtract these coupons from our overall estimate of non-response.

Although it would be equally as important to determine the characteristics of subjects who refused to accept a coupon—other than for the reason of already participating in the survey—this was not possible since the follow-up survey needed to minimise survey burden on the respondent, and some respondents experienced up to eight refusals. Therefore, we focused on the frequency of refusals encountered by respondents and the explanations provided in refusing to accept a coupon.

3.2 RDS methodology fisher focus group meeting

A RDS technical workshop was undertaken on 25-27 March 2014, at the Ecosciences Precinct, Brisbane to discuss the survey design and logistical details of a trial of RDS in the Tasmanian recreational set-line fishery (TRSF). The workshop was attended by international RDS experts, fisheries scientists, statisticians, a fishery manager, and recreational fishing group representatives. One key recommendation from the workshop was to undertake a focus group meeting with a diverse group of TRSF fishers to seek their feedback on specific aspects of the survey method, such as the incentive amount and type for participating in a questionnaire and recruiting eligible peers, and how they would most likely go about recruiting other fishers to the survey.

We asked existing contacts within the TRSF if they would be willing to participate in a focus group, and to extend invitations to other eligible fishers. We also sought the assistance from key recreational fishing stakeholder groups Recfishing Research (Brett Cleary) and TARFish (Mark Nikolai) to extend invitations to eligible fishers through their networks. The project objectives and focus group aims were explained to each potential focus group participant who requested to be part of the focus group. They were informed the meeting would take place in Devonport on 13 August 2014 for approximately 2-3 hours and they would be rewarded with a $50 eftpos card for their time and contribution. Although existing research and the invited expert to the RDS technical workshop indicated that set-line is almost exclusively undertaken in the northern half of Tasmania, we held a second meeting in Hobart on 14 August following the advice of Brett Cleary to cater for any set-line fishers in the region.

Focus group applicants were assessed on their location of residence, level of fishing experience, and whether they were a member of a fishing club or not. Our aim was to enlist a diverse group of fishers who would hopefully represent the full spectrum of fishers we would likely encounter in the formal RDS survey of the TRSF. Whilst we sought to have a diverse group of fishers, we also aimed to have a small enough group where open and honest discussion could take place where each participant could feel they could contribute. Therefore, we capped the focus group at 10 participants in each location. Although we confirmed 10 participants in each location, seven and two fishers actually attended and participated in the Devonport and Hobart workshops, respectively.

3.2.1 Workshop objectives

1. To inform recreational fishery stakeholders of the need for the current research project to trial a new method to representatively sample hard-to-reach participants in specialised recreational fisheries in Australia,

2. To seek honest and constructive feedback on the personal thoughts, opinions and perceptions of Tasmanian recreational set-line fishers with regards to a proposed survey approach and questionnaire to study the longline fishery using Respondent Driven Sampling (RDS),

3. To undertake a trial of the questionnaire to be administered to RDS respondents by telephone to collect demographic, social, economic, and fishing data on the Tasmanian recreational set-line fishery,

4. To seek expressions of interest from eligible recreational longline fishers to act as RDS survey ‘seeds’ to recruit the first wave of survey respondents for the formal longline study.

3.2.2 Focus group workshop structure

The same agenda was followed at both focus group workshop including:

1. Introduction of the project team,

2. Introduction of the participants, their fishing activities, and what they hope to get from the workshop,
3. The objectives of the workshop,
4. A brief background to the project and RDS, and the need to trial RDS to cost-effectively sample specialised recreational fishers,
5. Presentation of our proposed survey design for the formal RDS survey in Tasmania and invitation for comment and critique,
6. Focus group questionnaire relating to elements of the RDS survey approach,
7. Open discussion of identified issues,
8. Preliminary trial of the online questionnaire designed for the formal RDS survey of the Tasmanian recreational set-line fishery,
9. Wrap up, final comments and issue of reward cards.

The most important aspect of the workshops was to elicited honest responses from participants. It was reiterated during the introductory material that we sought honest and critical feedback since we aimed to produce a survey that could be implemented in any fishery in future. We were also aware that we were likely to have fishers with a range of personality types at the workshops and wanted to ensure each participant had an equal chance of having their opinions considered. In workshops there can be a small number of more vocal participants who may influence the thoughts and actions of other participants, which would be counterproductive to the aims of the workshops. We also wanted to record the initial opinions and thoughts of fishers when asked about specific aspects of the RDS survey (e.g. size and colour of survey coupons) since these are the thoughts that other fishers are likely to have when exposed to those aspects in the formal RDS survey. Therefore, we administered the questionnaire (Appendix 1) by revealing the question for 2-3 minutes on a projector screen (Figure 3.3) and having participants record their answer on a sheet that contained multiple choice answers or a blank space to record information (Appendix 2). This prevented participants revisiting earlier questions to change their answers in response to discussions or influences by other members of the focus group.

Figure 3.3: Photograph of the focus group workshop underway at Davenport, Tasmania on 13 August 2014.

3.3 Tasmanian recreational set-line fishery field trial

3.3.1 Population characteristics and questionnaire

To trial the efficacy of RDS in the TRSF it was necessary to first define the population characteristics that could be compared with data with a census of fishers using a telephone survey. The key population characteristics aimed to be monitored were gender (male, female), age (18-30, 31-50, 50+), region (e.g. north, west, south coast), fishing frequency (low avid, avid, high avid), fishing experience (novice, experienced), and fishing club membership (non-club member, club member). Census data for licensed fishers—for later comparison with the RDS survey data—was made available to the project by the Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE).

The questionnaire (Appendix 3) contained 43 items and was designed to be administered by telephone in 10-15 minutes by trained interviewers. The survey first collected general demographic information about the respondent that would serve as the main characteristics for comparison with the census data from the licence frame. These were followed by more specific questions relating to the respondent's fishing activities, followed by questions seeking information on the respondent's degree, which is critical for sample weighting by RDS estimators for estimating prevalence of population characteristics (e.g. gender). Three questions asked respondents to estimate their "extended degree" (all longline fishers they know in Tasmania), "immediate degree" (all longline fishers they know in Tasmania whom they would consider giving a coupon to), and "immediate monthly degree" (all longline fishers they know in Tasmania whom they would consider giving a coupon to, and were likely to see in the next 4 weeks).

3.3.2 Seeds and recruitment process

The RDS survey began by selecting 'seed' respondents who would serve to recruit the first 'wave' of fishers from the population. Since we had already recruited fishers to the focus group workshops who appeared well connected in the fishery and understood the RDS process, we contacted some of these individuals by telephone and invited them to participate. We chose six seeds to represent a diversity of fisher types, based on their geographic location (north, north east, west, and south coast), club membership (non-club members and club members), and perceived ability to communicate to objectives of the research and the RDS process to their peers.

An appointment was made with each seed to complete the questionnaire by telephone. On completion of the interview, each seed was sent an introductory letter explaining the objectives of the research (Appendix 4) and a reward and coupon kit (Figure 3.4). The kit contained three uniquely-coded paper coupons having a validity period of three months from the date of issue (Figure 3.5), a $20 cash-like eftpos card that was valid for twelve months (Figure 3.6), and instructions on how to distribute the coupons to eligible peers. Strict eligibility criteria were explained to the seed, and each subsequent respondent, and printed on the reward wallet. The criteria were that each person:

1) Must live in Tasmania,
2) Must be at least 18 years of age,
3) Must hold a recreational set-line licence,
4) Must fish, or intend to fish, with a recreational longline,
5) Has not previously participated in the survey, and
6) Must be someone the respondent knows personally.

Although respondents were sent paper coupons that they could physically pass to their peers, the rewards wallet also contained instructions for alternative referral methods. It was explained to the

respondent they could send the 6-character coupon code from each coupon and the survey free call telephone number to an eligible peer by email, social media, SMS or transcribed via telephone.

Recipients of a coupon (or code) were directed by their recruiter to call a toll-free telephone number—printed on the coupon—with a dedicated message service and leave their name, coupon code, and a preferred time and telephone number to be contacted. Project staff would check the message service twice per day and call back respondents at the appropriate time.

On completion of the survey, respondents were informed they would receive a secondary reward of $10 for each peer they recruited to the survey who met all six eligibility criteria, but if a peer was not eligible, they would not receive the reward for that peer and they would not be offered a replacement coupon. The secondary reward cards were sent in a different wallet in $10 denominations and a message of appreciation was printed on the wallet (Figure 3.7).

Following the advice of fishers who attended the March 2014 technical workshop and the focus group workshops, we aimed to begin the survey on 1 October 2014 to coincide with the peak fishing season and the finish the survey by October 2015. We recruited the first seeds and officially started the survey on 5 November 2014. Since we aimed to document the organic recruitment of fishers, we deliberately did not advertise the project because we did not want to influence the recruitment process by attracting; i) fisher who may have a preference to participate in research (i.e. volunterism), or ii) ineligible fishers who may seek out coupons to redeem for the reward.

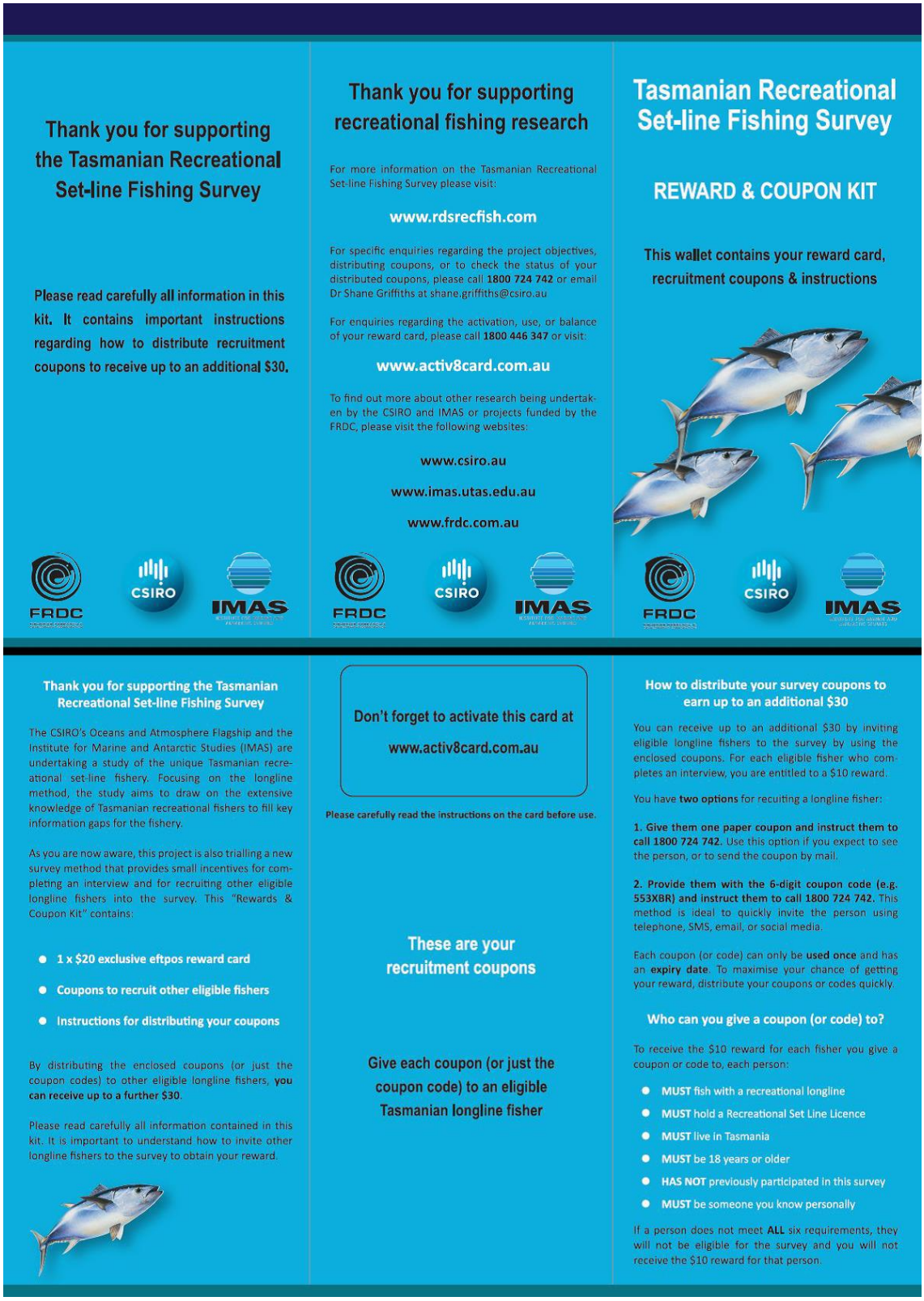

Figure 3.4: Illustrations of the reward and coupon kit sent to respondents after they completed the questionnaire for the Tasmanian recreational set-line fishery survey. The kit contained three yellow survey coupons and a $20 eftpos reward card.

Figure 3.5: Illustrations of the front (top) and back (bottom) of the yellow recruitment coupons issued to respondents in the Tasmanian recreational set-line fishery survey. Respondents were instructed to pass three coupons to eligible peers to recruit them to the survey. The coupons had an expiry period of three months.

Figure 3.6: Illustration of the eftpos reward card issued to respondents who completed the questionnaire for the Tasmanian recreational set-line fishery survey. The card had an expiry period of 12 months.

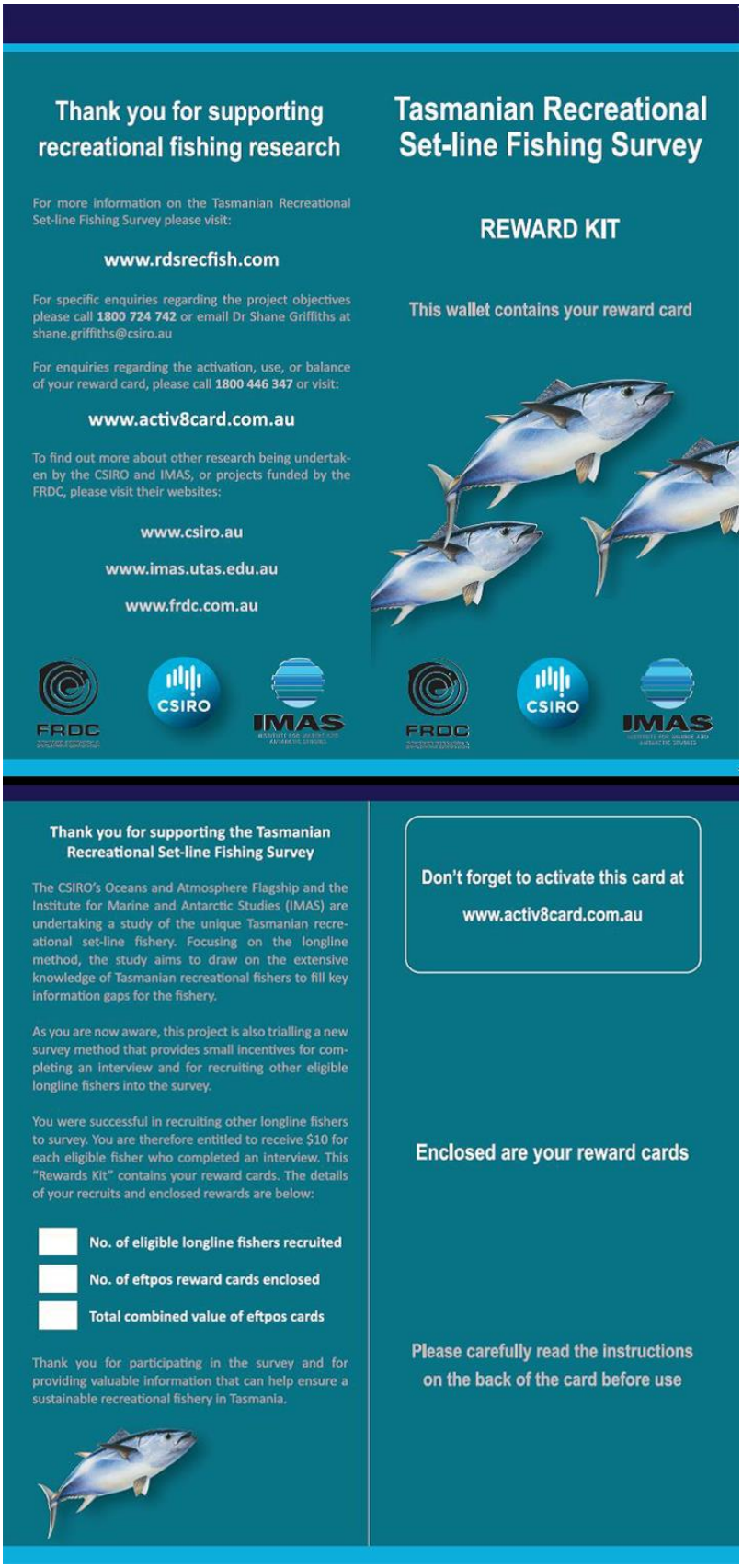

Figure 3.7: Illustrations of the secondary reward kit sent to respondents after they successfully recruited at least one eligible peer to the Tasmanian recreational set-line fishery survey. The kit contained the appropriate denomination of eftpos reward cards, being $10 for each peer recruited, up to a maximum of three peers.

3.3.3 Follow-up survey

Around four weeks after the RDS survey was complete, a follow-up survey of respondents was undertaken where we asked the same question of their "immediate degree" in order to assess how consistent each respondent estimated their degree. Among other questions, we also tested the assumption of the existence of reciprocal social ties with each member in each respondent's degree. Finally, we asked respondents a range of questions to better understand the motivations and impediments to participating and recruiting peers to the survey.

3.3.4 Analysis of the RDS sample

On completion of the RDS survey, data were analysed using RDS Analyst (RDS-A) software. We chose to compare the performance of three estimators for estimating the population prevalence of the three population characters using the RDS data: the crude or naive estimator, which uses the unadjusted RDS sample to produce population prevalence estimates for each character, RDS-II, or the Volz-Heckathorn estimator (Volz and Heckathorn 2008), and Gile's Sequential Sampling (SS) estimator (Gile 2011). Homophily was estimated by RDS-A for each population characteristic to determine the extent to which a particular group recruited from within or outside that group.

3.4 Tasmanian recreational rock lobster fishery field trial

3.4.1 Population and economic questionnaire

To trial the efficacy of RDS in the Tasmanian Rock Lobster Fishery it was necessary to first define the population characteristics that could be compared with data with a census of fishers using a telephone survey. The key population characteristics aimed to be monitored were gender, age, region, fishing frequency, fishing experience, and fishing/dive club membership.

The questionnaire (Appendix 5) contained 48 items and was designed to be administered by telephone in 10-15 minutes by trained interviewers. Besides from slightly different fisheries specific questions we followed the same procedure as reported for the set-line fishery in section 3.3.

In analysing the economic data we collected we used the following formula to determine the amount of money spent per lobster on average by seed fishers for each of the gear types.

$$\frac{[(Trip\ spending/Average\ trip\ length) \times Annual\ Fishing\ days] + Annual\ spending\ on\ lobster\ fishing}{number\ of\ Lobster\ caught}$$

3.4.2 Seeds and recruitment process

Seed recruitment phase 1

The RDS survey began by selecting 'seed' respondents who would serve to recruit the first 'wave' of fishers from the population. We looked for 'sociometric star' seeds by constructing a database of commercial business such as ship chandlers, tackle and dive shops that would come into regular contact with fishers. We then contacted these business via telephone to explain our research outcomes and seek their assistance as seeds. Many business responded that they had both avid fishers on staff and came into contact with many fishers on a weekly basis. Given the potential biases that can be introduced in RDS surveys by differential recruitment, we were concerned that geographic region in Tasmania (North vs South) and gear types (diver vs potter/ring) would present the largest potential impediment to recruitment in our survey. To address this issues, we planned to recruit a sufficient number of seeds from each region and gear type to maximise the probability of recruitment occurring

across boundaries and help the overall efficiency of the recruitment process for drawing a representative sample. We thus chose twenty seeds to represent a diversity of fisher types, based on their geographic location (North n = 10 vs South n = 10), fishing mode (potters/rings; n=10) and divers; n=10). North, South, dive and pot seeds were evenly distributed so each stratum had 5 seeds.

After first contacting and assessing potential seeds via telephone, an appointment was made with each seed. Project staff travelled around the state to personally brief seeds on the research, the intricacies of the method, complete the questionnaire in person and distribute the initial reward and coupons. This person-to-person and placed-based seeding was a return to how the RDS method has been traditionally implemented in other urban studies of hidden populations. On completion of the interview, each seed was provided with an introductory letter explaining the objectives of the research (Figure 3.8) and a reward and coupon kit (Figure 3.9). The kit contained three uniquely-coded paper coupons with a validity period of three months from the date of issue (Figure 3.10), a $20 cash-like eftpos card that was valid for twelve months (Figure 3.11), and instructions on how to distribute the coupons to eligible peers. Staff then personally provided seeds with a thorough explanation of both the RDS recruitment process and the strict eligibility criteria for potential recruits, which was also printed on the reward wallet. The criteria were that each person:

1) Must live in Tasmania,
2) Must be at least 18 years of age,
3) Must hold a current recreational rock lobster licence or held a licence in the previous season,
4) Must have fished or intend to fish, for lobster in the last 12 months or this season,
5) Has not previously participated in the survey, and
6) Must be someone the respondent knows personally.

Although respondents were sent paper coupons that they could physically pass to their peers, the rewards wallet also contained instructions for remote referrals. It was explained to the respondent they could send the 6 character coupon code of each coupon and the survey free call telephone number to an eligible peer by email, social media, SMS or transcribed by telephone.

Recipients of a coupon (or code) were directed by their recruiter to call a toll-free telephone number – printed on the coupon – having a dedicated message service and leave their name, coupon code, and a preferred time and telephone number to be contacted. Project staff checked the message service twice each day and called back respondents at the appropriate time.

On completion of the survey, respondents were informed they would receive a secondary reward of $10 for each peer they recruited to the survey who met all six eligibility criteria, but if a peer was not eligible, they would not receive the reward for that peer and they would not be offered a replacement coupon. The secondary reward cards (Figure 3.12) were sent in a different wallet in $10 denominations and a message of appreciation was printed on the wallet (Figure 3.11). In a further effort to reduce any perception that our study was a ‘scam’ we also provided a link to an official CSIRO hosted website that provided further information on the process and contact details (https://research.csiro.au/rdstaslobster).

We planned to conduct our survey from January to May 2017 as this coincided with the peak fishing season for rock lobster (Lyle et al. 2014a). We undertook our first round of seeding within the Tasmanian rock lobster recreational fishery between 18/1/2017 and 30/1/2017; meeting with 20 seeds who were working within fishing-related industries. Since we aimed to document the organic recruitment of fishers, we deliberately did not advertise the project because we did not want to influence the recruitment process by attracting fishers; i) who may have a preference to participate in research (i.e. volunteerism), or ii) ineligible fishers who may seek out coupons to redeem for the reward.

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Tasmanian Recreational Rock Lobster Survey

Dear fellow rock lobster fisher,

Thanks for helping us collect data to sustainably manage our rock lobster fishery.

Background and objective of the research

For many years scientists and managers have worked to improve the gathering of reliable data on recreational fisheries. This is far more challenging than for commercial fisheries where the numbers of operators are generally small, operators are licensed, and catch and effort reporting is compulsory. By contrast, the number of recreational fishers is large, they are dispersed throughout the entire community and their individual activities are extremely diverse. This makes collection of information that is representative of the activities of all fishers difficult.

The CSIRO and the Institute for Marine and Antarctic Studies (IMAS) at the University of Tasmania have received funding from the Fisheries Research and Development Corporation to trial an innovative survey approach that has the potential to be highly effective for particular recreational fisheries. The method is known as Respondent-Driven Sampling (RDS). This uses the fisher's social network to source eligible participants to take part in the survey. Our aim is to trial this method on a well-documented fishery and see if our new approach provides a representative picture of the fishery.

Nature of the research

This study will focus on the Tasmanian recreational rock lobster fishery. The scope of the survey will be on techniques used (dive, pot or ring) and the social and economic aspects of lobster fishing in Tasmania. The study consists of two components run in parallel, (1) a trial of the RDS method, and (2) a standard telephone survey of rock lobster fishers selected at random from the database of licence-holders. While both components will run independently of each other, they will collect the same information. Data will be shared with team members from both the CSIRO and IMAS. This will allow us to compare and contrast the two methods.

As the name suggests the RDS method is driven by the respondents, with fishers asking their fishing friends to participate. All participant will be given a reasonable reward ($20) for taking part in the survey. If you can then recruit up to 3 more fishers to participate you will receive an additional $10 reward for each successful recruit.

Your role in the research

Your role is to be a 'seed' or initial respondent to begin the survey chain in your social network of fishing friends. Your task is to first answer the survey and to distribute your 3 referral coupons to other eligible rock lobster fishers within your home region. Enclosed is a wallet containing your initial $20 reward, 3 coupons, and detailed instructions on how to distribute your coupons. If you have any questions regarding the project, please do not hesitate to contact me on (03) 6232 5239.

Kind regards,

Dr Tim Lynch
Senior Research Scientist
CSIRO Oceans & Atmosphere

Figure 3.8: Letter to the 20 'seeds' respondents of the Tasmanian Recreational Rock Lobster survey where RDS was used to sample licence holders.

Figure 3.9: Illustrations of the reward and coupon kit sent to respondents after they completed the questionnaire for the Tasmanian recreational rock lobster fishery survey. The kit contained three yellow survey coupons and a $20 eftpos reward card.

Figure 3.10: Illustrations of the front (top) and back (bottom) of the yellow recruitment coupons issued to respondents in the Tasmanian recreational set-line fishery survey. Respondents were instructed to pass three coupons to eligible peers to recruit them to the survey. The coupons had an expiry period of three months. For our second wave of seeds we extended this date till 30th July.

Figure 3.11: Illustrations of the eftpos reward card issued to respondents who completed the questionnaire for the Tasmanian recreational rock lobster fishery survey ($20) and the card to be placed into the secondary reward kit sent to respondents after they successfully recruited at least one eligible peer to the Tasmanian rock lobster fishery survey.

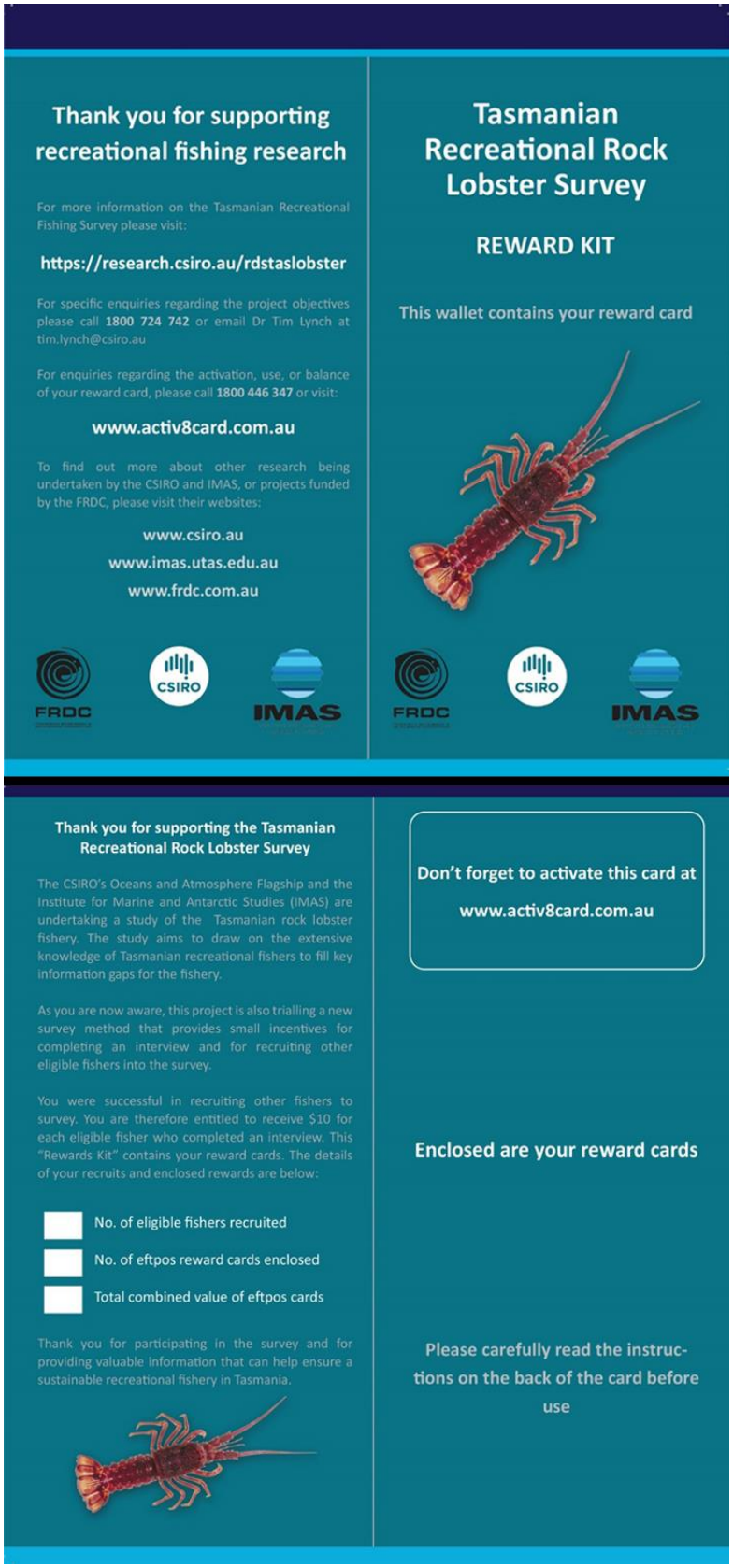


Figure 3.12: Secondary reward kit sent to respondents after they successfully recruited at least one eligible peer to the Tasmanian rock lobster fishery survey. The kit contained the appropriate denomination of eftpos reward cards, being $10 for each peer recruited, up to a maximum of three peers.

3.4.3 Reseeding: Seed recruitment phase 2 and 3

As it became apparent that we were not rapidly recruiting respondents from our initial 20 seeds, we continued to introduce new seeds in an attempt to produce robust recruitment chains. We commenced a second round of seed recruitment in mid-March 2017 and a third in mid-June 2017but focused our efforts on SCUBA divers, the only group that had responded in the first round. We targeted dive clubs and held organised social events in an effort to recruit fishers. We also made further adjustments to the method in an effort to increase participation. First, we seeded within an organised gathering a volunteer sub-section of SCUBA dive club members rather than with individuals from commercial businesses after providing briefings to the club executive and then a presentation to all members. We also increased the initial incentive, providing $40 to each club member for attending (paying for dinner and a drink) as well as $20 for the sub-section of volunteers who completed an interview. We completed focus group meetings with seeds at the Tasmanian University Dive Club (TUDC) (Figure 3.13), Ocean Divers, Tasmanian Underwater Dive Club (TUDC) and the Tasmanian SCUBA dive club. Two clubs were based in the South (TUSC and TUDC) and the other two in the North.

Figure 3.13: Staff interviewing lobster fishers from the Tasmanian University Dive Club during the second phase of seed recruitment.

3.4.4 Follow-up survey

Four weeks after the first round of RDS seeding survey was complete, a follow-up or ‘wash-up’ survey of respondents was undertaken where we asked questions (Appendix 6) to better understand the motivations and impediments to participating and recruiting peers to the survey.

Results

4.1 ESP staff wellbeing pilot survey

4.1.1 Population census data for ESP staff

A total of 827 staff members was deemed to be in-frame residents of ESP, having a direct fixed telephone line assigned to their name. These staff represented eight agencies: Department of Science, Information Technology and Innovation (DSITIA) (312), CSIRO (282 staff), Department of Agriculture, Forestry and Fisheries (DAFF) (201), Department of Natural Resources and Mines (DNRM) (12), University of Queensland (UQ) (7), Department of Environment and Heritage Protection (EHP) (6), Griffith University (GU) (6), and University of the Sunshine Coast (USC) (1). The breakdown of staff by agency, building level and gender is given in Appendix 7. To protect staff confidentiality, names have been omitted from the manifest and replaced with an arbitrary staff ID number.

4.1.2 General RDS survey results

A total of 394 coupons was issued during the RDS study, yielding 197 eligible respondents and one ineligible respondent who did not know his recruiter personally. No individuals attempted to participate in the survey more than once, or to impersonate an eligible subject. Given the known population size of 827, the RDS sample represents a sampling fraction of 23.8%. The rate of recruitment increased rapidly between week 3 and 9, before reaching an asymptote. The cumulative number of coupons issued followed a similar trend through time (Figure 4.1).

A total of 175 of the 197 eligible respondents (89%) participated in the follow-up survey, with two respondents declining to participate, 12 respondents confirmed to no longer work at ESP, while the remaining eight respondents were unable to be contacted after eight telephone calls.

Of the respondents recruited to the survey, 37% did not recruit anyone, while 29% and 34% recruited one and two eligible subjects, respectively (Figure 4.2). The majority of respondents distributed both of their coupons to an eligible peer on the same day they received the coupons, or the following day (Figure 4.3).

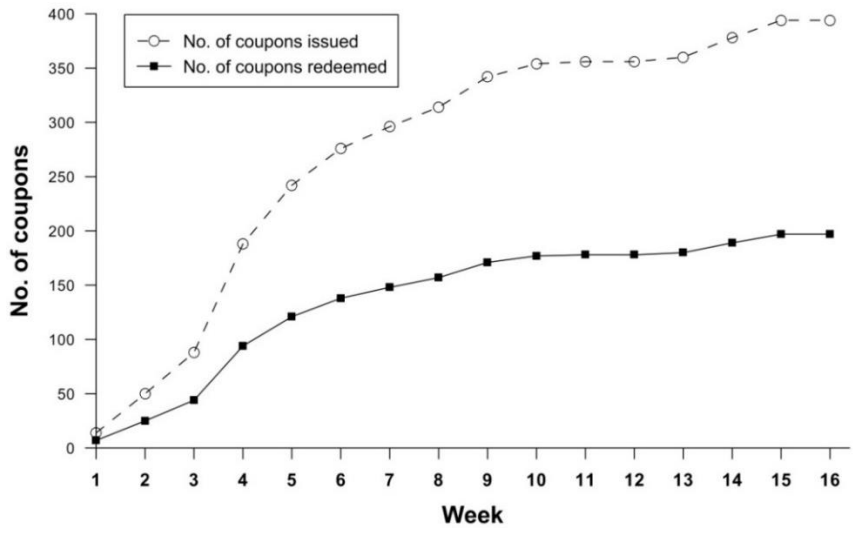


Figure 4.1: Cumulative number of issued and redeemed coupons per week during a survey of government workers at the Ecosciences Precinct using Respondent Driven Sampling.

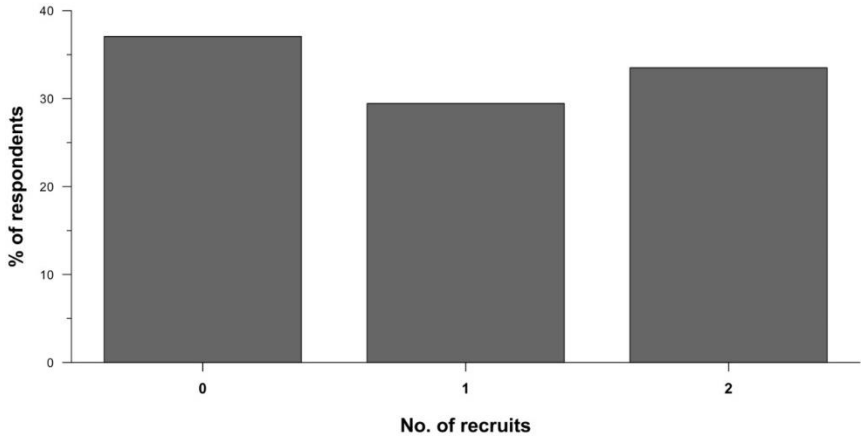


Figure 4.2: Percentage of respondents in the RDS survey at the Ecosciences Precinct who recruited zero, one or two eligible peers to the survey.

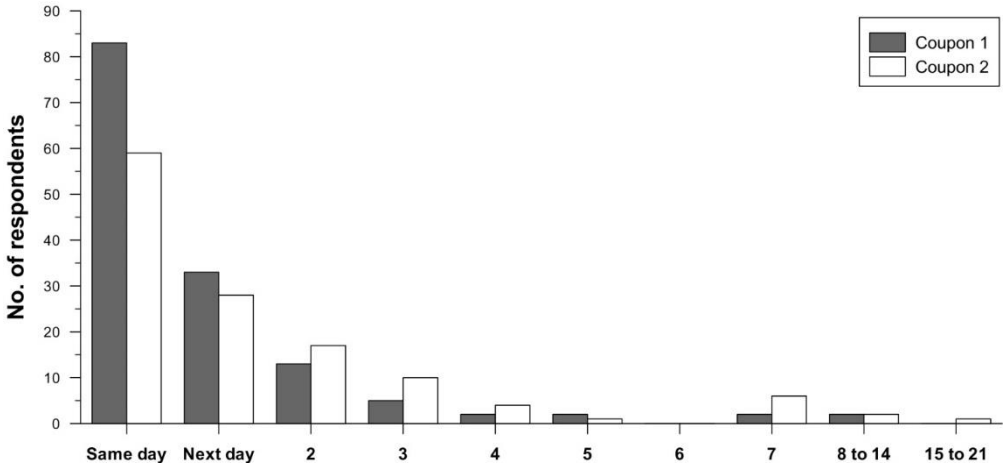


Figure 4.3: Number of days taken by respondents to have each of their two RDS coupons accepted by a peer at the Ecosciences Precinct.

4.1.3 Motivations for survey participation

Respondents indicated that their primary reason for participating in the survey was to collect the reward of a free beverage at the ESP cafe (37%), a favour to the person who offered the coupon (who was often said to be driven to collect their secondary beverage reward) (29%), to contribute to the knowledge of staff well-being at ESP (23%), or because they like to participate in any type of research (9%) (Figure 4.4). Other reasons included respondents having an interest in the sampling procedure and one respondent felt they were coerced by their peer to participate.

Almost all respondents (97%) believed that the initial reward of the free beverage was appropriate recompense for calling the survey telephone line, requesting an interview time, and participating in the interview. The remaining 3% were unsure if the incentive was adequate since they did not drink coffee, despite the voucher being redeemable for any type of beverage including water, and soft drinks.

When respondents were asked whether they would have still participated in the survey if no reward was offered, 64% believed they would, while 22% and 14% said they would not participate or were unsure (Figure 4.5).

4.1.4 Peer selection by respondents

In order to understand the recruitment dynamics within RDS surveys and to determine if the assumption of random peer selection within an individual's network is maintained, respondents were asked to report the primary way they selected a potential peer to offer a coupon. The two major selection strategies were closely coupled, being peers they most frequently interact with at ESP (23%) and peers who were physically located closest to the respondent's workstation. The strategy that would indicate that peers were not selected preferentially was "diverse range of peers", which was utilised by only 2% of respondents (Figure 4.6).

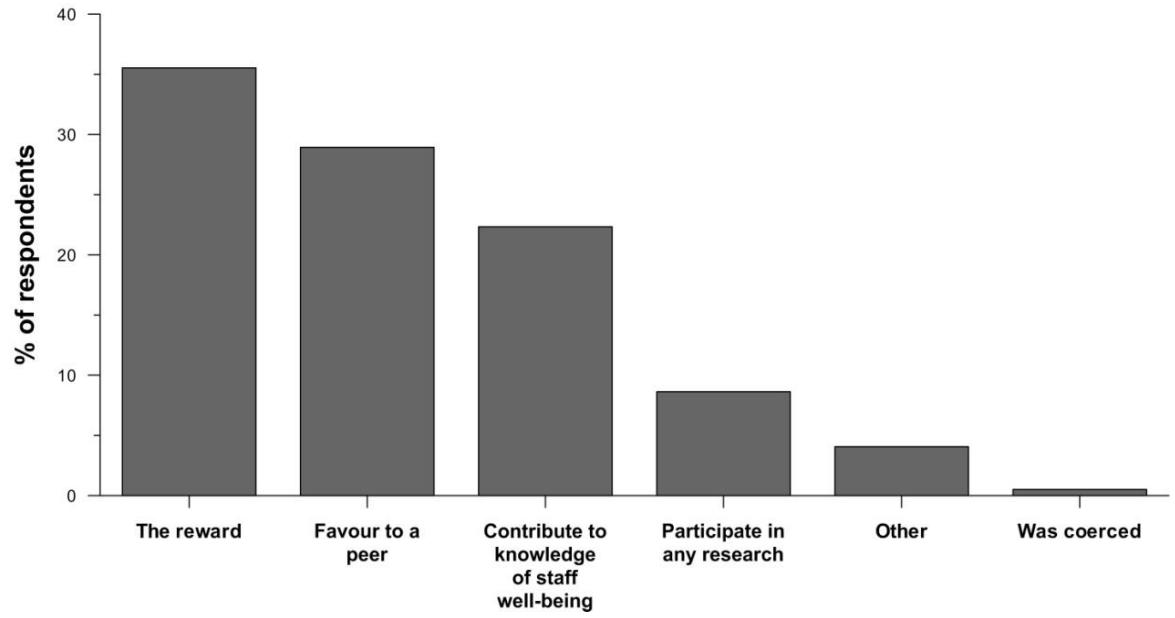


Figure 4.4: Primary motivations for staff at the Ecosciences Precinct to redeem their coupon to enter the staff well-being survey.

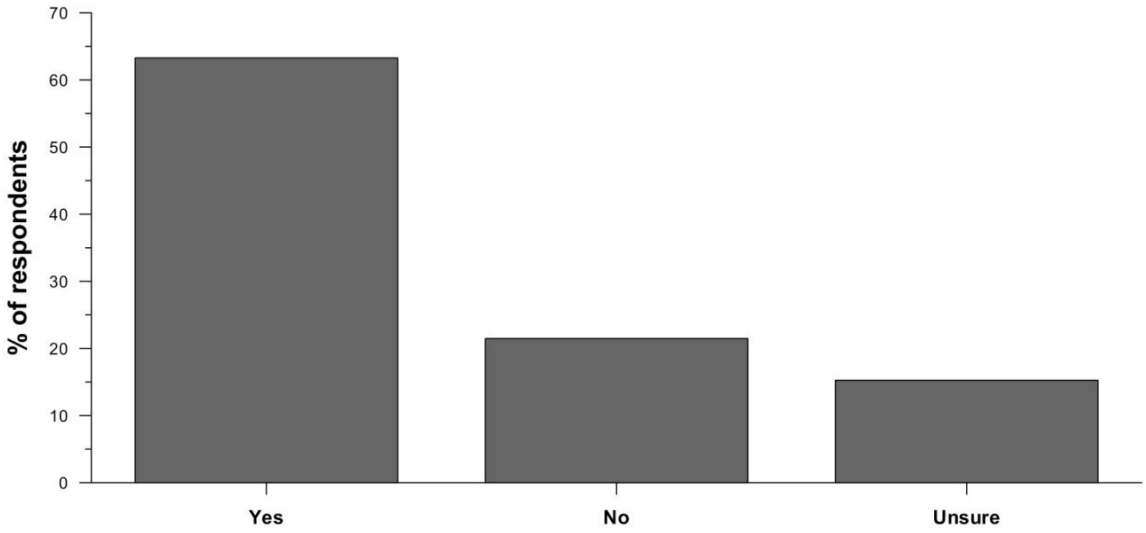


Figure 4.5: Percentage of respondents who would participate in the Ecosciences Precinct staff well-being survey if no reward was offered for participation.

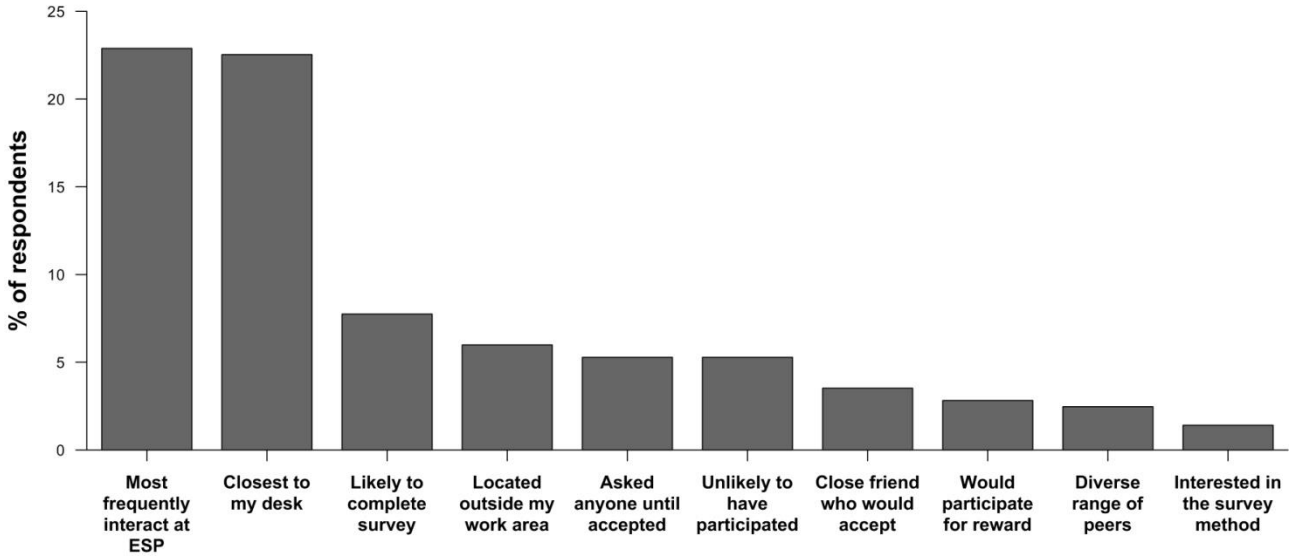


Figure 4.6: Percentage of respondents selecting a primary strategy for selecting peers whom they offered a coupon to invite into the Ecosciences Precinct staff well-being survey.

4.1.5 Degree of respondents

Respondents estimated having degree sizes ranging from 3 to 600 peers, with the average being 36.38 (± 1 SD 27.37) peers (Figure 4.7). Figure 4.7 clearly illustrates the presence of rounding bias for degree estimates, with respondents generally reporting degree sizes in multiples of five or ten. This rounding appears to worsen with degree sizes above 30, which appear to increase in multiples of ten.

For each agency, the mean reported extended degree was higher—albeit not statistically—than that of the immediate degree, often by more than 30 (Figure 4.8). When respondents were asked to estimate their immediate degree 4-6 weeks later in the follow-up survey (i.e. the "recalled immediate degree"), the mean estimates were higher than the initial estimates for each agency (Figure 4.8). When asked

about their "reverse degree" (i.e. how many of their peers may consider recruiting them if the their peers were recruited to the survey first), the mean value was lower than the recalled immediate degree.

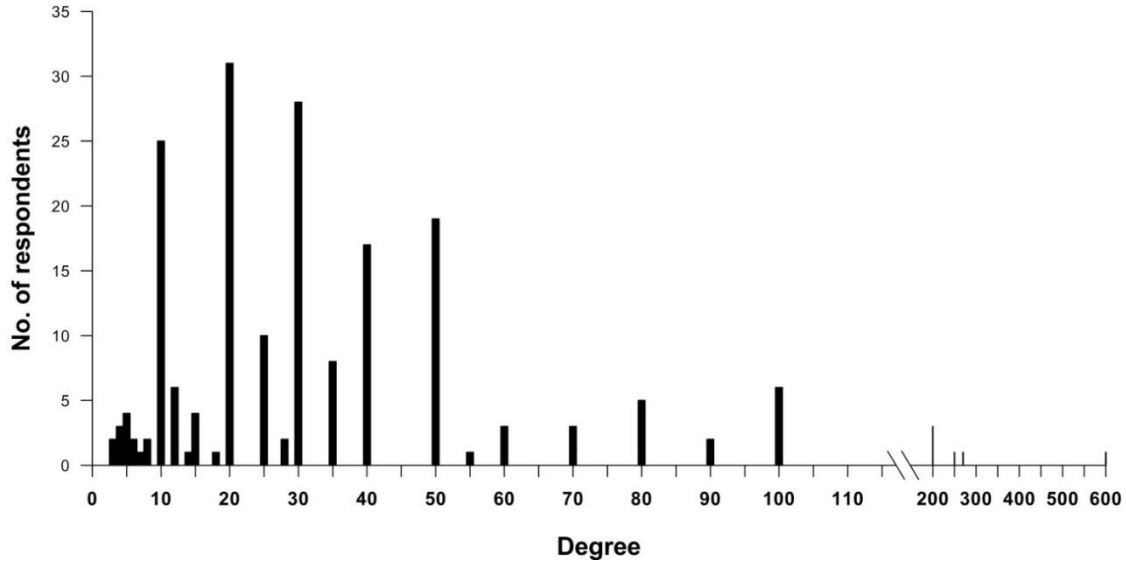


Figure 4.7: Self-reported "extended degree" estimates provided by respondents at the Ecosciences Precinct.

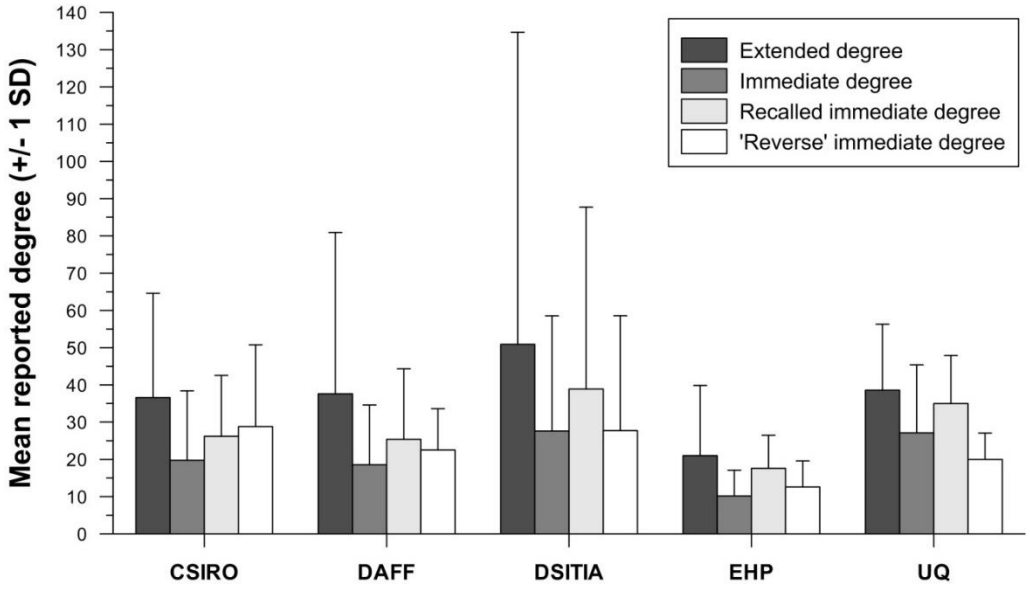


Figure 4.8: Mean (± 1 SD) size of four types of self-reported degree measures estimated by respondents from each agency at the Ecosciences Precinct. For detailed descriptions of each degree type refer to Methods section.

4.1.6 Recruitment dynamics

Figure 4.9 illustrates the recruitment process initiated by seven 'seed' respondents. One seed failed to recruit any respondents, four seeds did not progress beyond the first wave, one seed progressed to the third wave, while the remaining (CSIRO, Male, L1) produced 92% of the sample from 18 waves. RDS

was highly effective at accessing staff from 7 of the 8 agencies at ESP, and notably staff from USC and UQ which census data indicate were represented by only 1 and 8 staff, respectively.

Examination of the RDS sample composition by wave shows CSIRO being the predominant agency in the first four recruitment waves, which is replaced by an increasing diversity of agencies in successive waves to the point that no CSIRO respondents are represented after wave 11. This indicates that the composition of the final sample was unlikely to have been biased by the composition of seeds or respondents in the initial sampling waves.

An important aspect of Figure 4.9 is the high homophily of agency and building level (see Section 3.1.5 below), highlighting the potential for recruitment bottlenecks. This can present a serious sampling bias if the network is constrained and fails to penetrate the full sociometrics diversity of the population. Results from diagnostic tests for bottlenecks with respect to each population characteristic are shown in **Error! Reference source not found.**.

With regards to agency, Figure 4.10 shows a gradual change in the sample proportion of the three primary agencies with increasing recruitment and the absence of abrupt changes in the sample proportion late in the study, which indicative recruitment bottlenecks. The abrupt increases in recruitment for DNRM, EHP and USC would normally indicate a bottleneck, but this is because these agencies are represented by few individuals, and their representation rapidly declined by the end of the survey.

Similar to agency, sample proportions for building level and gender gradually changed with increasing recruitment, with an absence of sudden changes in population proportions (Figure 4.11).

The target sample size was 248, however only 197 respondents were recruited to the survey before all coupons expired. Therefore, it was necessary to determine whether the level of sampling was adequate to represent the ESP population and not be biased by the composition of seeds. The convergence plots (Figure 4.12) shows the estimated population proportion of each agency and building level, using the RDS-II estimator, levels out after around 160 respondents had been recruited to the study. The convergence plot for gender shows the population proportion was relatively constant after the study had recruited around 110 respondents. These results suggest that sufficient sampling was undertaken to provide a representation of population characteristics of staff at the Ecosciences Precinct.

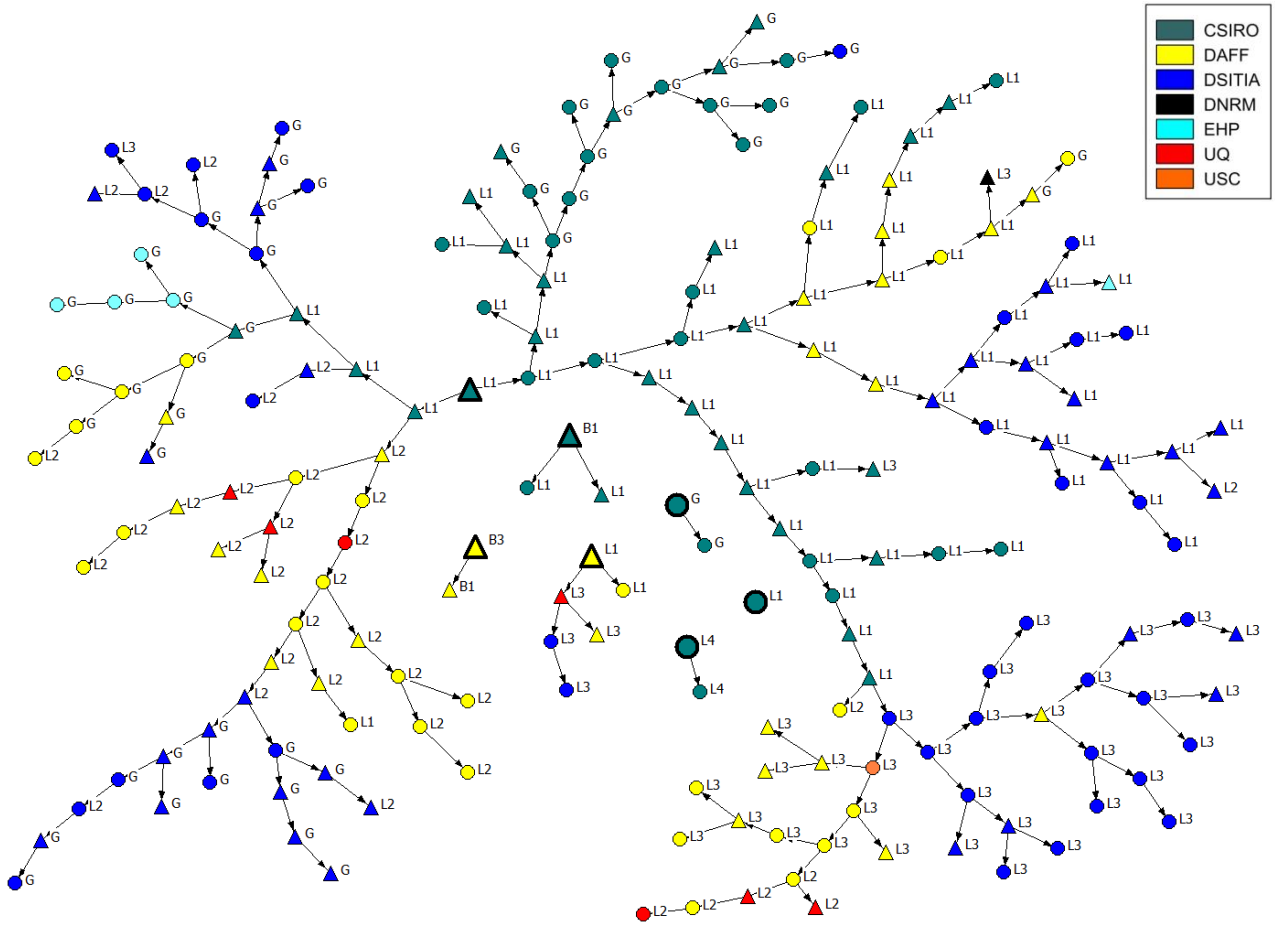


Figure 4.9: Recruitment chains for respondents recruited to the staff well-being survey at the Ecosciences Precinct using Respondent-Driven Sampling initiated by eight seeds (large node markers), each distributing a maximum of two recruitment coupons. Each node represents an individual respondent being male (triangles) or female (circles), and representing a specific agency (CSIRO, DAFF, DSITIA, DNRM, EHP, UQ, and USC). Labels accompanying each node denote the building level where the respondent's fixed telephone line is located.

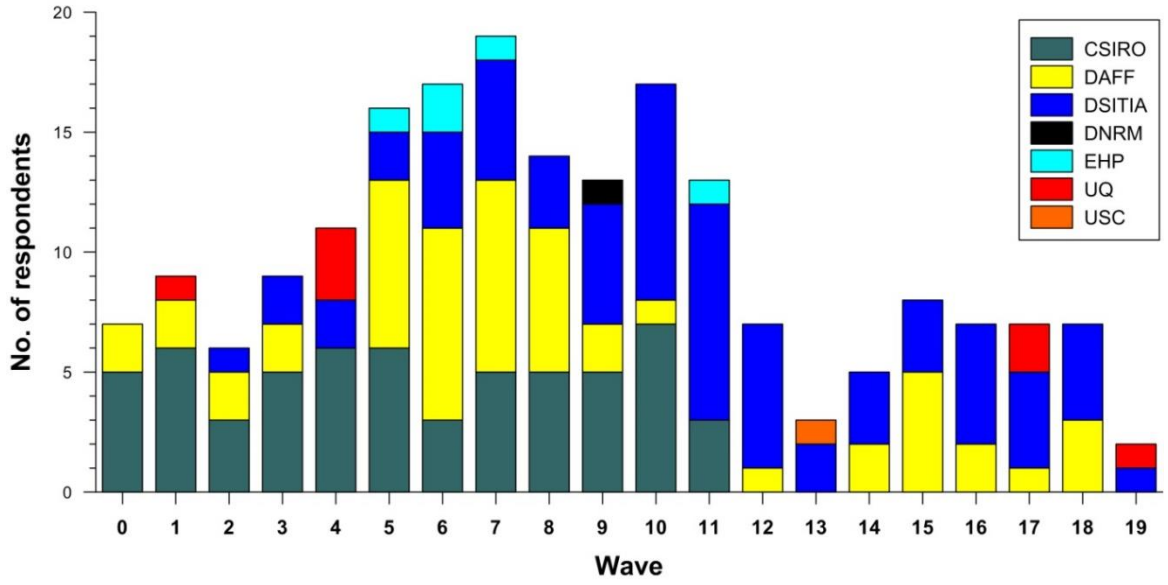


Figure 4.10: Sample composition by agency for each recruitment wave of the staff well-being survey using Respondent-Driven Sampling at the Ecosciences Precinct. Each colour represents a different agency (CSIRO, DAFF, DSITIA, DNRM, EHP, UQ, and USC).

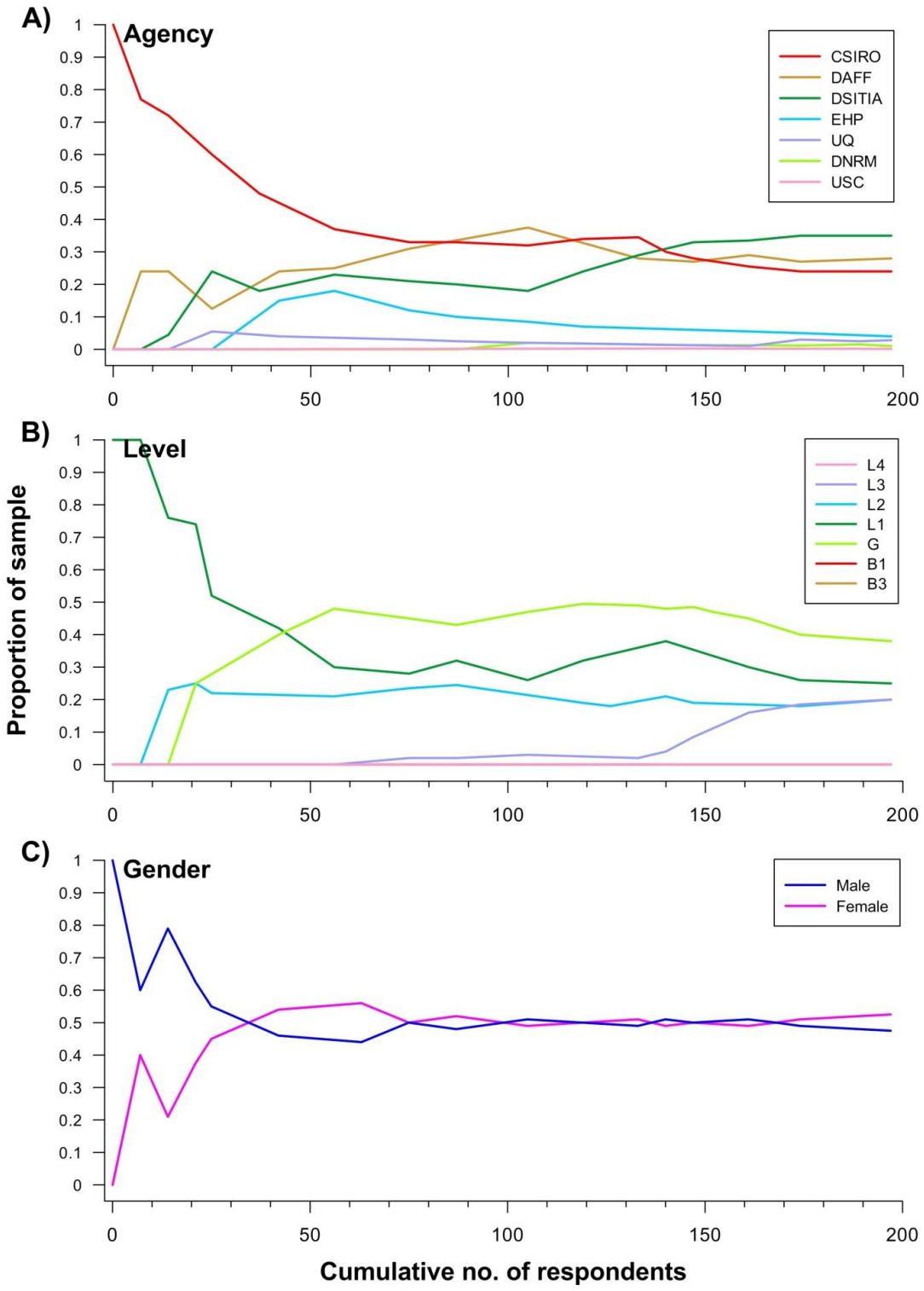


Figure 4.11: Diagnosis of recruitment bottlenecks by examining the change in sample proportions of each agency (top), building level (middle) and gender (bottom) with increasing recruitment during a staff well-being survey at the Ecosciences Precinct using respondent-driven sampling.

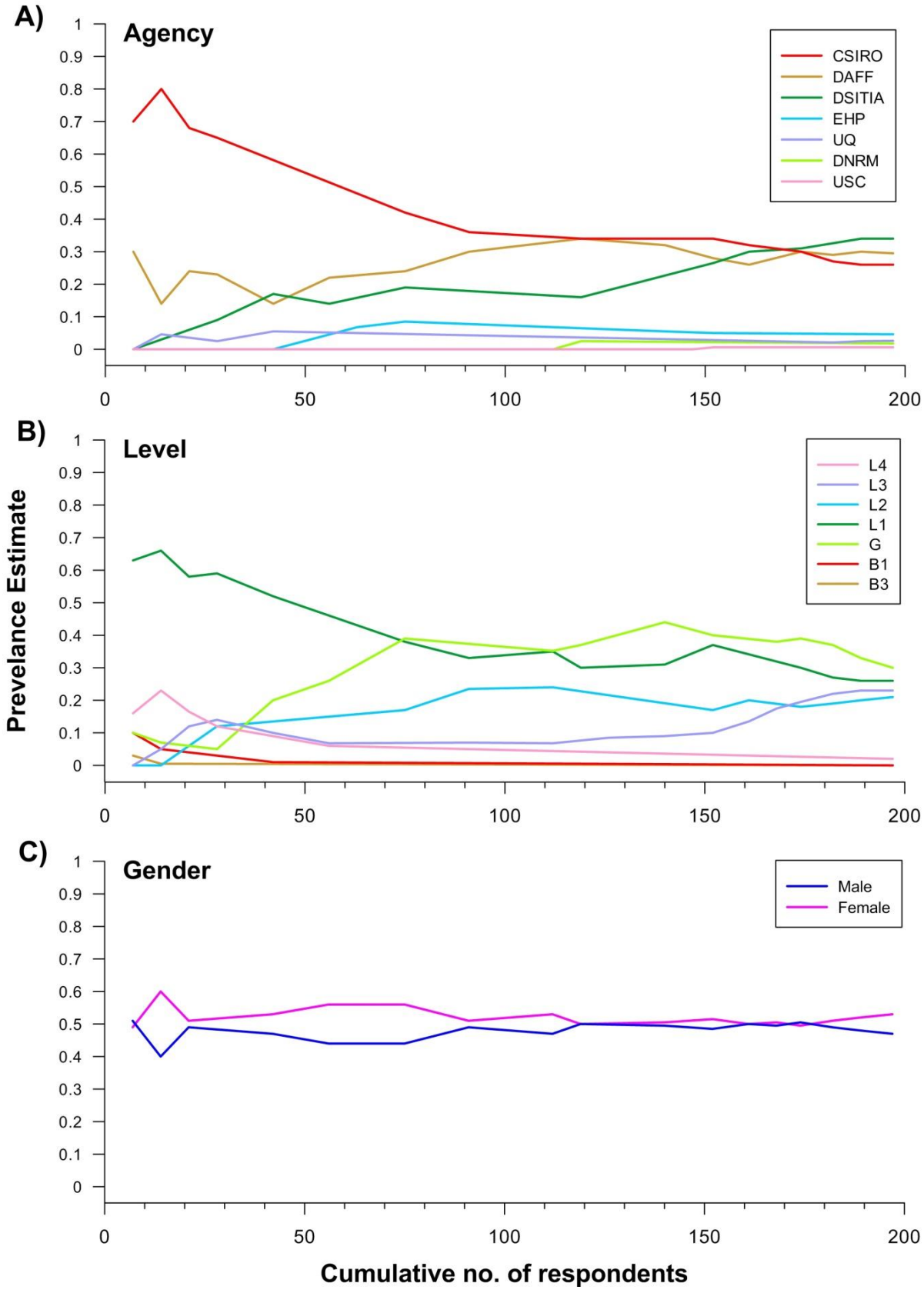


Figure 4.12: Convergence plots showing the estimated population proportion of each agency (top), building level (middle) and gender (bottom) with increasing recruitment in a staff well-being survey at the Ecosciences Precinct using respondent-driven sampling.

4.1.7 Homophily

There was a high degree of homophily among two of the three major population characteristics used to define the ESP population. Building level had the highest homophily value with respondents 3.3 times more likely to recruit someone on the same level as themselves than expected by chance. People were also 2.75 times more likely to recruit someone within the same agency as themselves. In contrast, gender had a homophily of only 1.14, indicating that respondents generally did not preferentially distribute their coupons to subjects having the same gender as themselves. High homophily for level and agency is clearly seen in Figure 4.9, particularly for agency, by the distinct clustering of similar node colours.

Differential recruitment—indicated by high homophily—can create a sampling bias that may not be easily corrected by RDS estimators, particularly if the average degree sizes of respondents representing different characters do not markedly differ. By comparing population prevalence estimates for each characteristic by RDS estimators with those of census data will determine whether differential recruitment introduced a major source of sampling bias (see Section 4.1.8).

4.1.8 Estimated population prevalence

After observing that the RDS sample converged to a stable state for the characters of agency, building level and gender, and that no significant recruitment bottlenecks were present, RDS data were analysed to produce population prevalence estimates for agency, building level and gender. The accuracy of these RDS estimators was assessed by comparing with the actual population prevalence from census data.

Agency

The actual population prevalence of each agency (Figure 4.13) was: DSITIA 37.7%, CSIRO 34.1% and DAFF 24.3%, with the remaining five agencies comprising 3.9% of the ESP population. Given the rarity of the latter five agencies, while census and random sampling data are provided performance of RDS estimators only were undertaken for DSITIA, CSIRO and DAFF. When we undertook simple random sampling (SRS) from the census data, we produced population proportion estimates that were within 4.7% of the actual. In comparison, the RDS crude estimator was 5% and 12% lower than the actual for DSITIA and CSIRO, respectively, but was 12% higher for DAFF (Figure 4.13). The RDS-II and Gile's SS estimators produced similar mean estimates for the population prevalence of the three agencies; these were around 5% and 30% lower than the actual for DSITIA and CSIRO, and around 20% higher for DAFF (Figure 4.13). The standard errors for these two estimators were large (often >50%), which is a function of the high homophily (2.75) for this character.

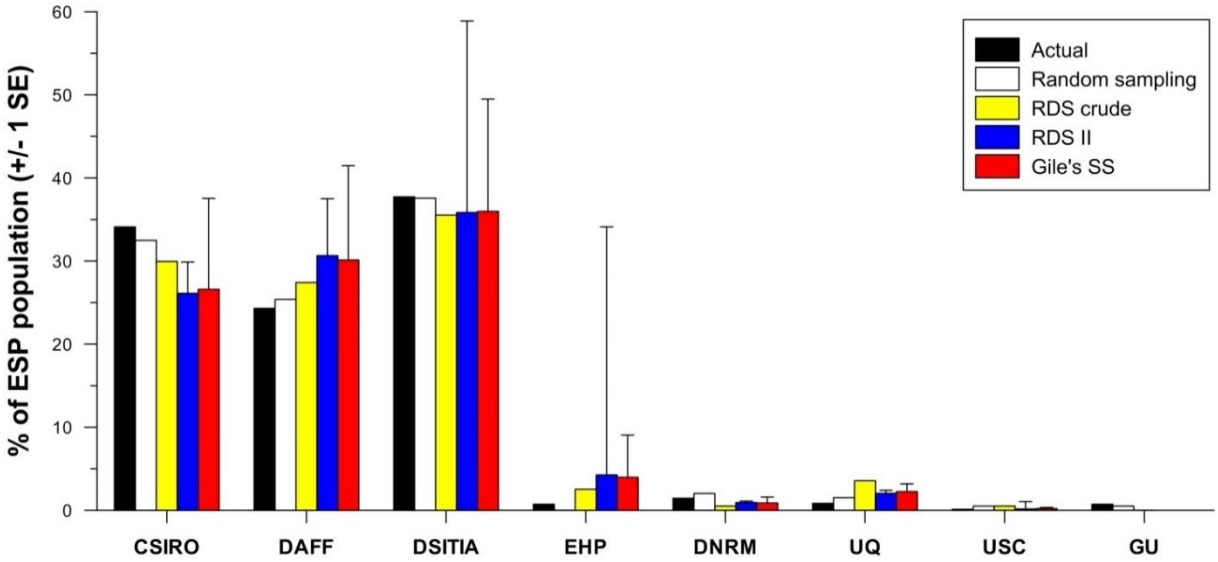


Figure 4.13: Ecosciences Precinct population proportion by agency estimated by Respondent-Driven Sampling and standard random sampling compared to the actual population prevalence derived from the October 2014 census of staff. Three types of RSD estimators are shown: the RDS crude estimator, the RDS-II estimator, and Gile's Sequential Sampling (SS) estimators using a total population size of 827 derived from the ESP census data.

Building level

With respect to building level, the census data show that the majority of the ESP population occupy levels G (23.1%), L1 (31.2%), L2 (21.6%), and L3 (21%), with levels B3, B1 and L4 comprising the remaining 2.3% (**Error! Reference source not found.**). Our RDS chains successfully spread to staff from each of these seven levels. Similar to agency we focused our RDS methods comparisons to the four primary levels. Simple random sampling from the census data produced population proportion estimates that were within 9.4% of the actual. The RDS crude estimator produced similar estimates as random sampling for levels G and L3 being within 7.7% and 3.5% of the actual, respectively. RDS crude estimates were 6.5% higher and 15.8% lower than the actual for L1 and L2, respectively. The RDS-II and Gile's SS estimators produced similar mean estimates as the RDS crude estimator for the population prevalence of L2 and L3. In contrast, for level G these two estimators were 40% and 35.7% higher than the actual, respectively; and 15% and 12% lower than the actual for L1 (Figure 4.14). The large standard errors for these two estimators were a function of the high homophily (3.30) for this character.

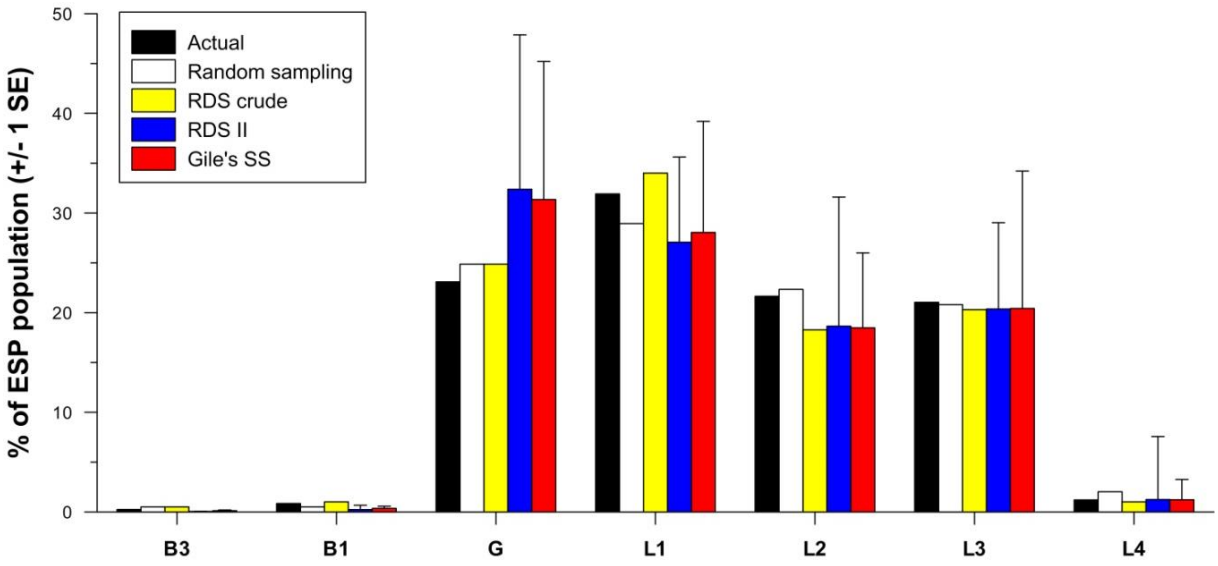


Figure 4.14: Ecosciences Precinct population proportion by building level estimated by Respondent-Driven Sampling and standard random sampling compared to the actual population prevalence derived from the October 2014 census of staff. Three types of RSD estimators are shown: the RDS crude estimator, the RDS-II estimator, and Gile's Sequential Sampling (SS) estimators using a total population size of 827 derived from the ESP census data.

Gender

Census data showed that males and females constituted 55% and 45% of the ESP population (Figure 4.15). Simple random sampling produced population proportion estimates of 4% and 4.9% for males and females, respectively. The RDS crude estimator produced population proportion estimates that were 18% lower and 15% higher than the actual for males and females, respectively (Figure 4.15). The RDS-II and Gile's SS estimators produced very similar mean estimates as the RDS crude estimator for

both males and females (Figure 4.15). The small standard errors for these two estimators are a result of low homophily (1.14) for the gender character.

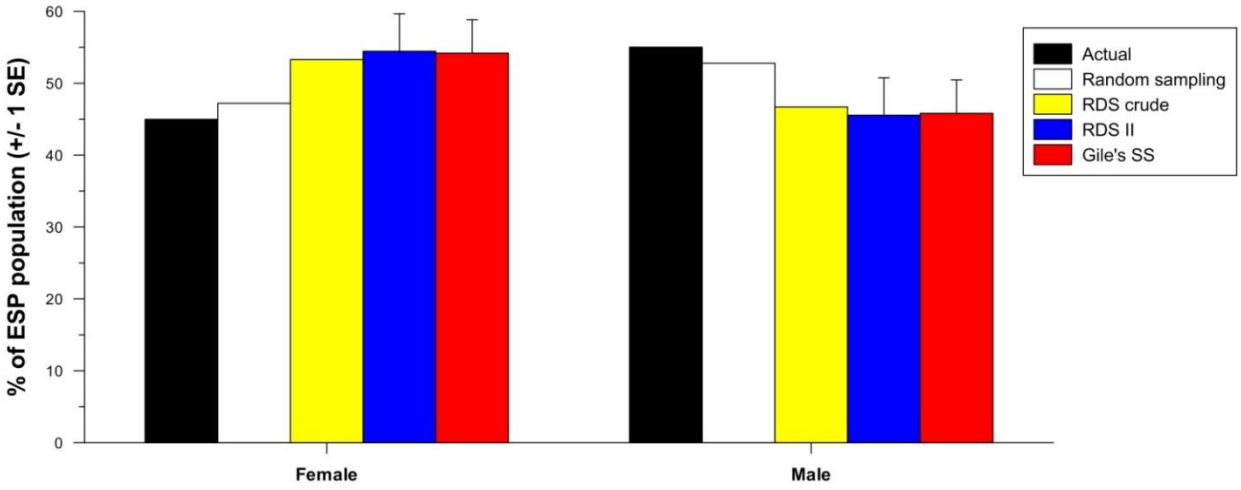


Figure 4.15: Ecosciences Precinct population proportion by gender estimated by Respondent-Driven Sampling and standard random sampling compared to the actual population prevalence derived from the October 2014 census of staff. Three types of RSD estimators are shown: the RDS crude estimator, the RDS-II estimator, and Gile's Sequential Sampling (SS) estimators using a total population size of 827 derived from the ESP census data.

4.1.9 Non-response

In total, 197 of the 394 coupons issued to respondents were relinquished, indicating a non-response rate of 50%. Of the 197 unrelinquished coupons, the follow-up survey revealed that 84 coupons were not issued. Of these, respondents did not attempt to distribute 50 coupons, 20 were attempted to be distributed but were not accepted by anyone, while the remaining 14 expired before respondents could distribute them. The latter issue may be a result of some recruiters taking the entire seven day coupon validity period to distribute coupons (see Figure 4.3), leaving little time for coupon recipients to relinquish their coupon. Therefore, 113 coupons were accepted by peers but were never relinquished, indicating a total non-response rate of 28%.

Profiles of non-respondents

With respect to agency, the percentage contribution to the sample of non-respondents was lower than for respondents for DAFF (26.5% cf. 24.3%) and DSITIA (33.7% cf. 35.5%). In contrast, the contribution of CSIRO staff to the sample of non-respondents (37.8%) was higher than for respondents (30%) (Figure 4.16).

With respect to building level, the percentage contribution to the sample of non-respondents was higher than for respondents for L1 (21.4% cf. 18.3%) and L2 (22.5% cf. 20.3%). In contrast, the contribution of staff on level G to the sample of non-respondents (24.9%) was lower than for respondents (20.4%, while on L1 contributions by respondents and non-respondents were roughly equal (Figure 4.17).

For gender, the contribution of males to the sample of non-respondents (57.1%) was higher than for respondents (46.7%), while the reverse was true when comparing female non-respondents (42.9%) and respondents (53.3%) (Figure 4.18).

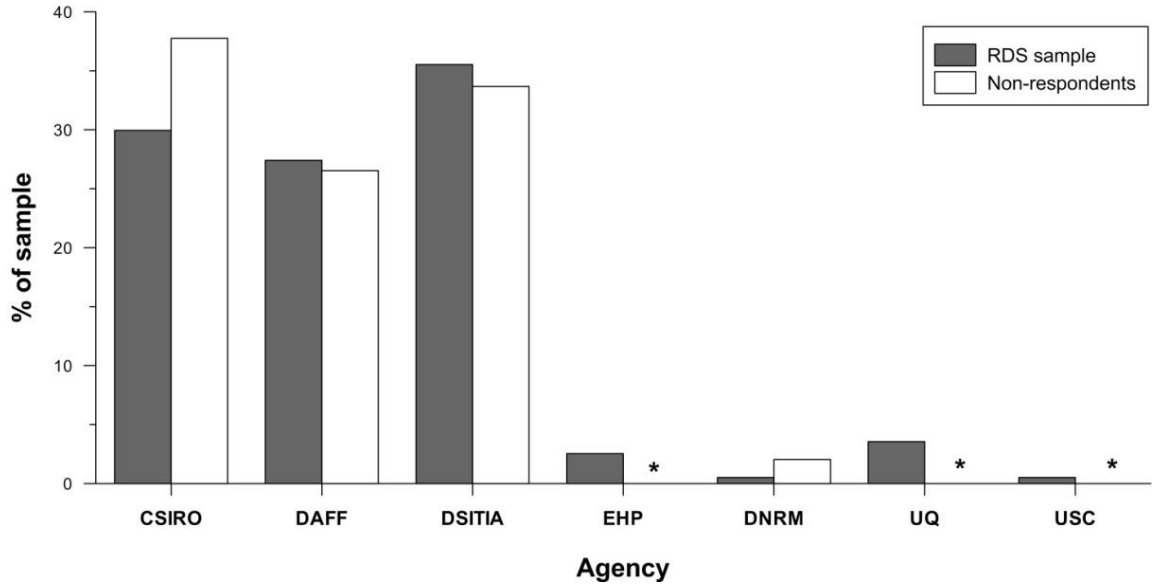


Figure 4.16: Percentage of respondents by agency in the crude RDS sampled taken during the Ecosciences Precinct staff well-being compared to the percentage of non-respondents reported by RDS respondents. The RDS sample was not adjusted using a RDS estimator. Asterisks indicate strata where non-respondents were not reported.

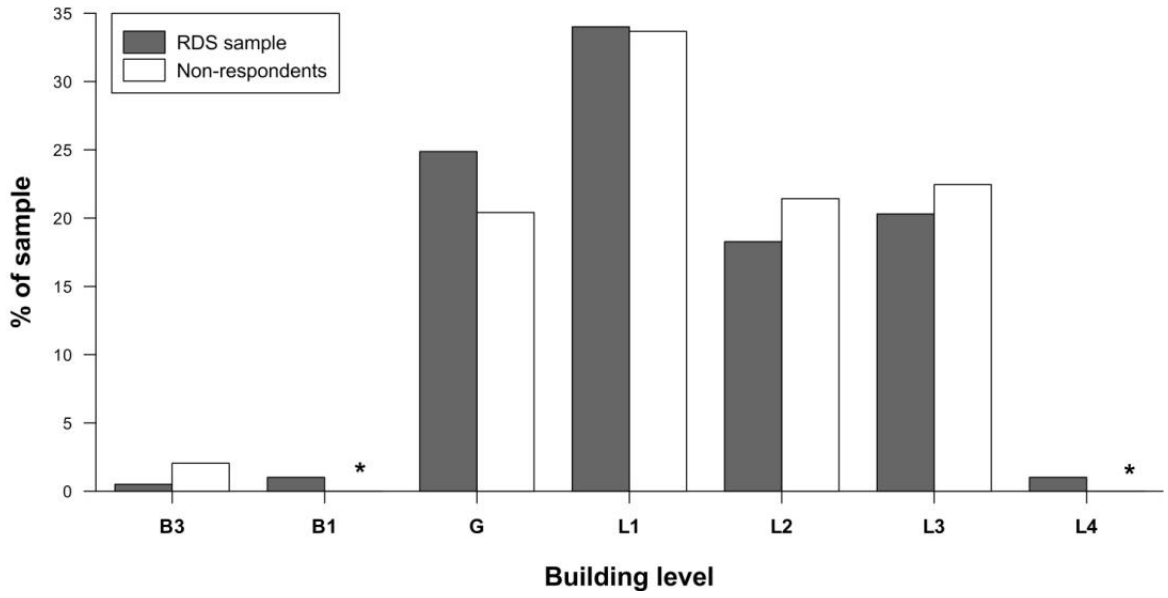


Figure 4.17: Percentage of respondents by building level in the crude RDS sampled taken during the Ecosciences Precinct staff well-being compared to the percentage of non-respondents reported by RDS respondents. The RDS sample was not adjusted using a RDS estimator. Asterisks indicate where non-respondents were not reported.

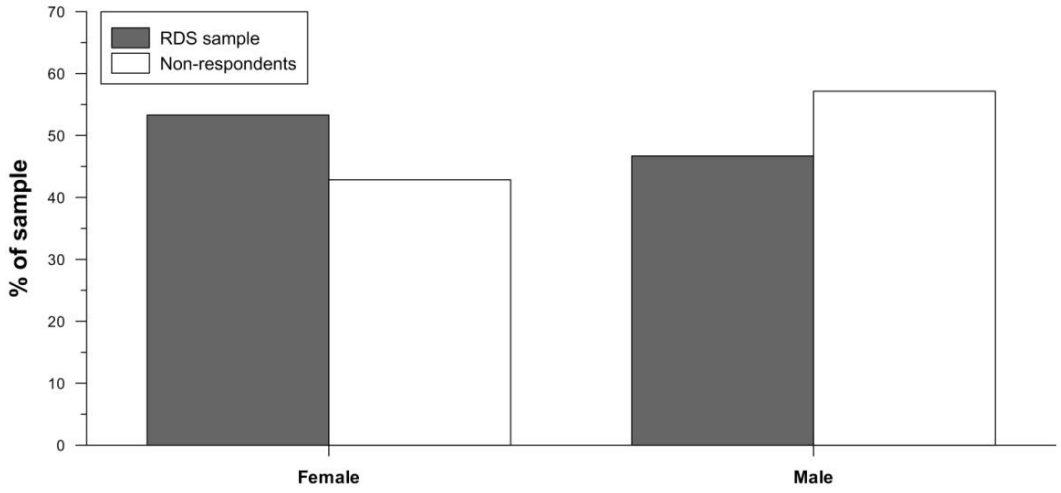


Figure 4.18: Percentage of respondents by gender in the crude RDS sampled taken during the Ecosciences Precinct staff well-being compared to the percentage of non-respondents reported by RDS respondents. The RDS sample was not adjusted using a RDS estimator. Asterisks indicate strata where non-respondents were not reported.

4.1.10 Refusals

A total of 150 refusals were incurred by respondents attempting to distribute coupons to peers during the ESP well-being survey. However, it is unknown how many individuals refused to accept a coupon since the same individual may have refused a coupon offered by different respondents. Overall, 52% of respondents did not have a coupon declined; however, the remaining 48% of respondents generally encountered 5 or fewer refusals, while one respondent reported experiencing 31 refusals (Figure 4.19).

The primary reason given to respondents by subjects declining a coupon was that they had already participated in the survey (70.4%), were not interested in the subject matter of the study (15.5%), or were too busy to participate (7.0%) (Figure 4.20). Only 2.8% of ESP staff reported refusing to participate due to an inappropriate or insufficient incentive. This result aligns well with the 3% of respondents who felt the reward was inappropriate or insufficient (see section 4.1.3) and indicates that any non-response or refusals in the survey cannot be attributed to the incentive offered.

In small populations where the sampling fraction is high, it may be possible for the frequency of refusals to increase with time as an increasing proportion of the population are recruited into the study and become ineligible to recruit subsequent coupons. This was not the case in the ESP survey with the highest number of refusals coinciding with the peak in successful recruitment between week 4 and 9 (Figure 4.21).

Refusals due to subjects indicating they had already participated in the survey were reasonably consistent through time, comprising around 70-80% of weekly refusals (Figure 4.21). Interestingly, the first seven respondents recruited to the survey, occurring in week 1, indicated that they incurred 5 refusals due to subjects already participating. Given that these seven respondents were located in various areas of the building and worked for different agencies, it was unlikely that they were attempting to recruit each other. Therefore, these results suggest that a subject stating they had already participated may be a strategy to politely decline a coupon, or a 'soft refusal'. Alternatively, it may be a strategy for respondents to appear to the researcher that they attempted to co-operate and distribute coupons when in fact they did not try, did not have peers to give the coupons to, or had the coupons declined.

Determining the validity of refusal reasons in later weeks of the survey is more difficult since the number of recruits increased dramatically. However, anecdotally, a significant number of people

within the first few weeks of the survey had stated to researchers issuing reward vouchers that they could not distribute their coupons because "everyone in the building has already participated". This was obviously untrue since even by the end of the survey, only 310 coupons (after non-issued coupons have been omitted) were issued to staff in a population of 827. This may indicate that the perceptions of staff probably reflect what is occurring in their immediate surroundings in their wing or building level and are not actively passing coupons to peers, or do not know any eligible peers, outside of their immediate area. This notion appears to be substantiated by the high level of agency and building level clustering seen in the RDS recruitment chains (Figure 4.9).

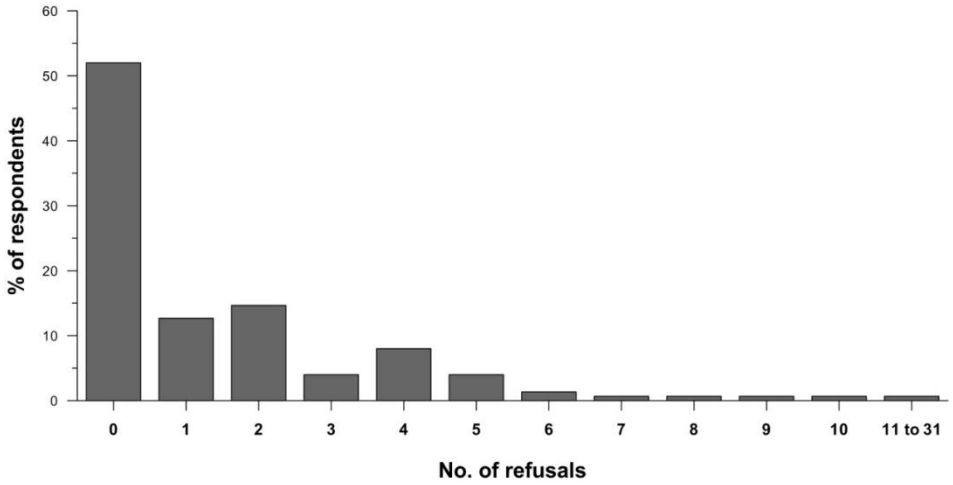


Figure 4.19: Percent frequency of incidents of staff at the Ecosciences Precinct declining to accept a coupon from respondents in a staff well-being survey.

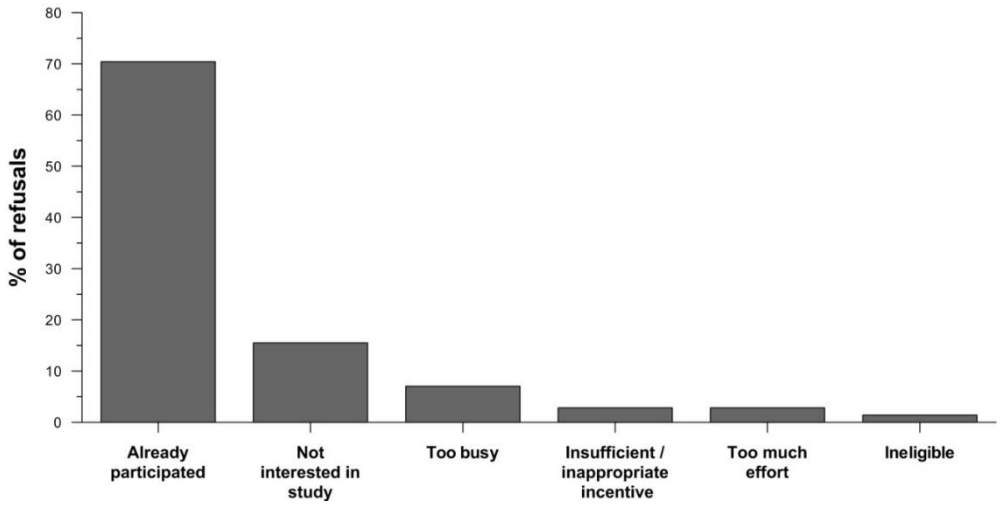


Figure 4.20: Primary reason given by staff at the Ecosciences Precinct to decline a coupon offered by respondents to participate in a survey of staff well-being.

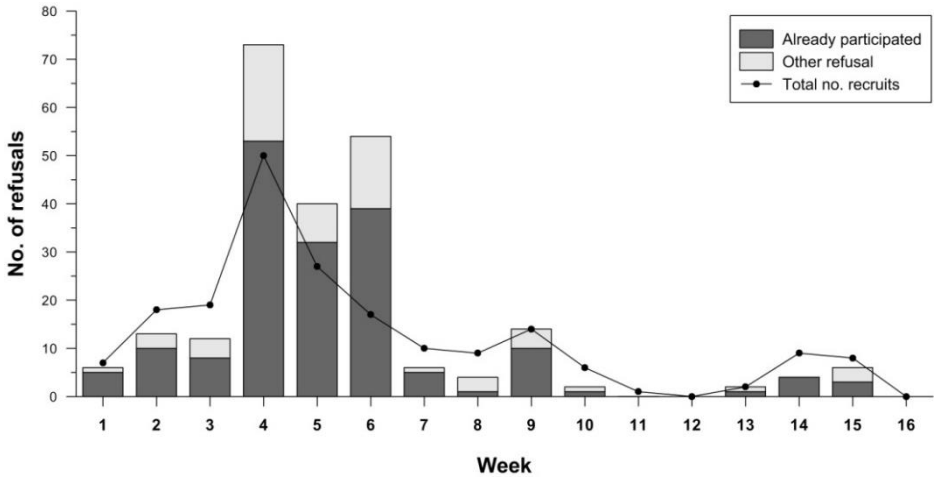


Figure 4.21: Primary reason given by staff at the Ecosciences Precinct to decline a coupon offered by respondents to participate in a survey of staff well-being.

4.2 RDS methodology focus group

A total of nine set-line fishers took part in the focus group workshops. During the introductions participants expressed a genuine interest in the project and contributing to the design of the survey. This also allowed the project team to determine that each participant was an active fisher in the longline fishery, since there was initially some confusion whether we were studying the longline or dropline fishery—both are covered under the Tasmanian Set-line licence.

We were interested in having a mix of fishers who were either a member of a fishing club or not, since club members generally represent only a small fraction of all recreational fishers in Australia and are often more experienced and avid than non-members. Furthermore, we also considered club members to potentially have larger social networks with the fishery and that those ties may be with other experienced and avid fishery, thereby potentially biasing the RDS recruitment dynamics. The final mix was 44% club members and 56% non-members.

4.2.1 Fisher experience and avidity profiles

Of the focus group participants, all reported to have had at least 20 years of overall fishing experience, indicating that they were all likely to have their own established fishing social networks. The participants had a wide range of experience specifically with longline fishing ranging from less than five years (67%) to more than 20 years (22%). Similarly, the number of days fished in the previous 12 months varied from zero to 10-29 days, although 50% of participants fished with longlines on 5-9 days (Figure 4.22).

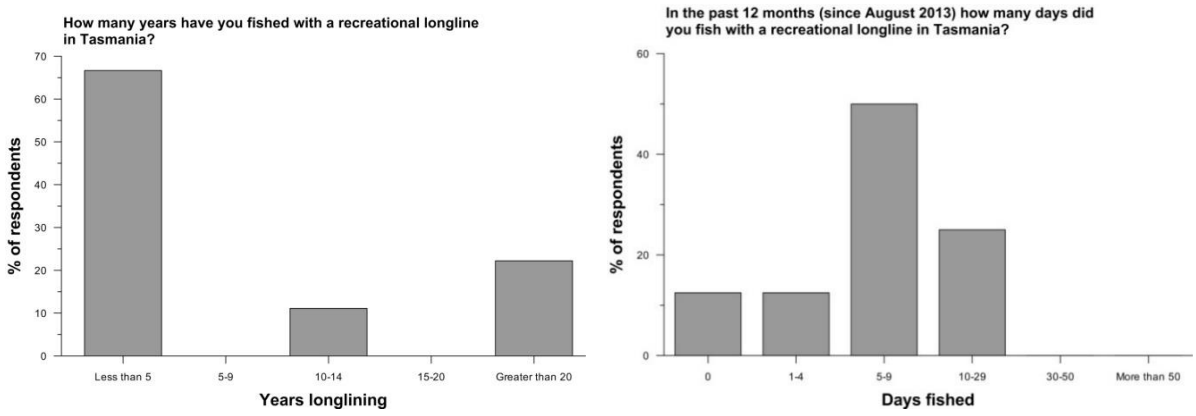


Figure 4.22: Responses from focus group participants reporting their years of longline fishing experience (left) and fishing frequency in the previous twelve months.

4.2.2 Spatial and temporal extent of longline fishing activity

It was important for the project team to identify the main locations where longline fishing takes place in order to find suitable 'seed' respondents who could start the recruitment chains in those regions. Ideally, a number of seeds would be selected from spatially separated regions in order to expedite the recruitment process. It is also important to understand the peak fishing times in the longline fishery so that the recruitment process is underway during the peak fishing time when fishers are most likely to be in contact with each other.

The majority of focus group participants (76%) undertook their longline fishing activities in the north of the state (northwest to northeast) with the remaining 24% fishing on the southeast coast (Figure 4.23). In the March 2014 workshop it was understood that the longline fishing season was short, extending from around October to March. The peak months of fishing effort by focus group participants was November to March (Figure 4.23), but it was determined the fishing season extends well beyond these months. In fact, 76% of the group fished with a longline throughout the entire year to some extent.

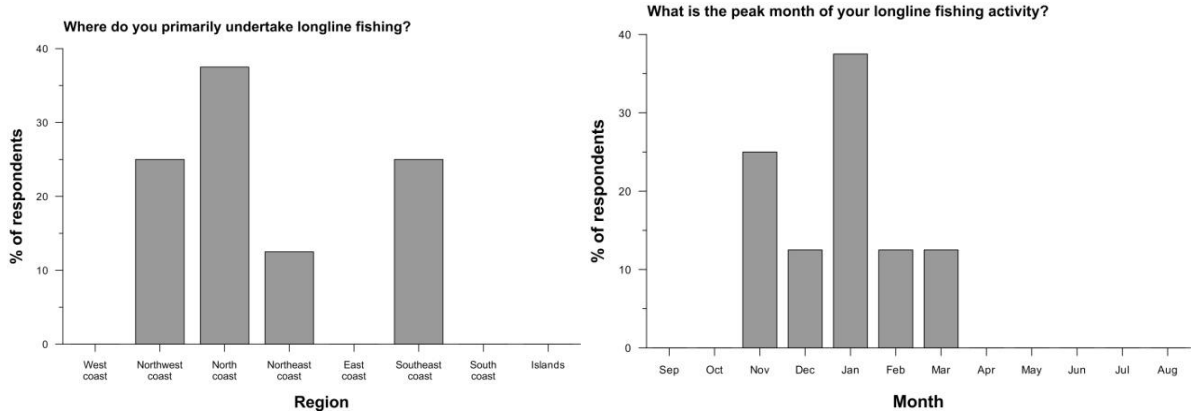


Figure 4.23: Responses from focus group participants reporting where they primarily fish in Tasmania and the peak month of their longline fishing activity.

4.2.3 Behavioural and attitudinal responses to RDS survey components

4.2.3.1 Impressions of RDS coupons

RDS works by an eligible member of the target population passing a physical coupon with a unique code to another eligible subject whom they know personally. Previous work with hidden stigmatised populations (e.g. illicit drug users) has shown that the coupon itself can influence the decision by someone to accept a coupon. For example, in some hidden populations the literacy level may be low and therefore a coupon with excessive text may introduce anxiety and subsequent decline of accepting a coupon. In some populations it may be desirable to design a coupon that appears to have financial value that reflects the reward value in order to encourage acceptance of the coupon by subjects who may be primarily motivated to participate by the reward alone. However, such coupons may also appear to some subjects to be a scam or elaborate advertising. For example, coupons with gold embossed stamps are used by some periodical companies to generate a perception that the coupon has value.

We developed a number of coupon prototypes ranging from plain-coloured card to illustrations resembling an Australian $20 note with holographic strips (Figure 4.24). We proposed a scenario where the focus group participants were approached in a social situation and were offered one of the coupons, both of which were shown on Powerpoint and hard copies passed around the room.

Encouragingly, no participant indicated that they would decline acceptance of the coupon or thought the coupon appeared to be a scam. Figure 1 shows that 67% of participants felt they would accept the coupon and make a decision whether to participate at a later time, while the remaining 33% believed that the coupon represented a legitimate invitation that they would follow up on (Figure 4.25).

Figure 4.24: Two of the coupon designs circulated among focus group participants for comments in being used in a respondent-driven sampling survey of Tasmanian recreational set-line fishers.

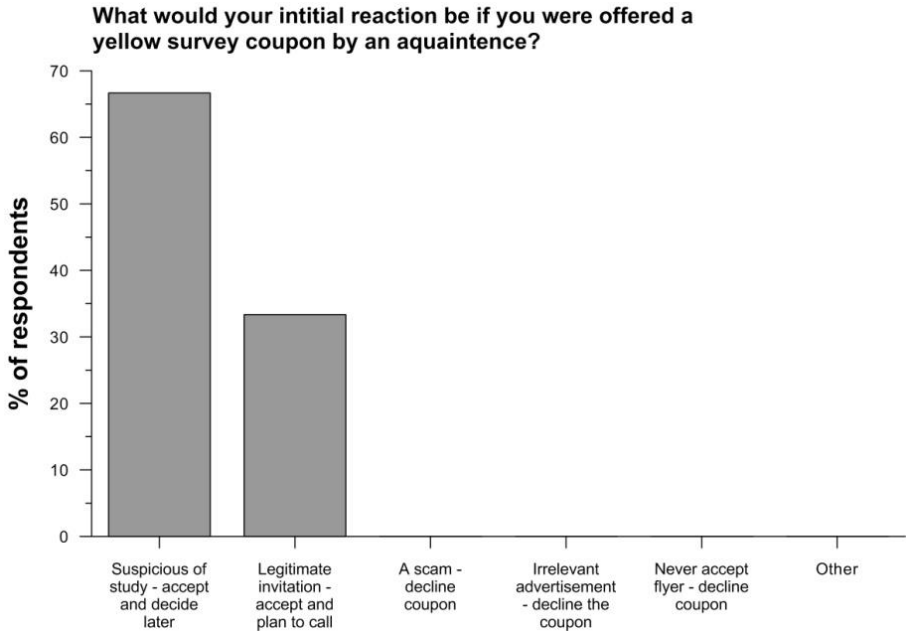


Figure 4.25: Responses from focus group participants regarding their initial thoughts on being presented a respondent-driven sampling coupon as an invitation to participate in a longline fishing survey.

4.2.3.2 Contacting survey staff to recruit to the survey

Most RDS surveys to date have been conducted in urban settings where respondents are required to visit one of several medical clinics to participate in an interview and redeem their reward. In contrast, most recreational fishing surveys that would employ RDS are likely to be conducted over large spatial scales where it is not practical to establish physical locations where coupon holders can visit. Therefore, in the March 2014 technical workshop the group agreed that all correspondence be made by telephone. There were some concerns with using telephone as the initial contact method, primarily whether call costs would be an issue that would increase non-response. With the assistance of the focus group we explored whether the project would need to establish a toll-free number, or whether respondents were willing to pay for the call costs. This can be a significant cost to a project, especially in the TRSF where surveys are being conducted from Brisbane but the respondents are located in Tasmania.

All respondents indicated that they would make a telephone call to be admitted into the study. However, 67% of participants indicated they would only call if the call cost was equivalent to a local call, while the remaining 33% believed they would only call if the call was free (Figure 4.26).

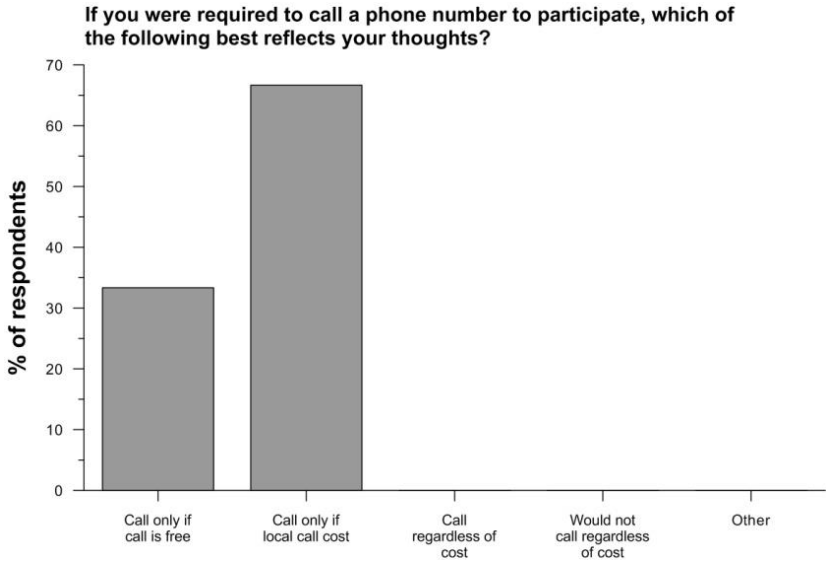


Figure 4.26: Responses from focus group participants regarding their preference to call a survey line to participate in the Tasmanian recreational fishing longline survey.

A further consideration of using telephone as the primary contact method was the preferred days and times when RDS respondents would likely wish to be able to contact survey staff. Feedback from RDS experts at the technical workshop indicated that it is not cost-effective to have survey staff available constantly to process new recruits. This is mainly because recruitment often occurs in pulses when peers are in contact, and there can be protracted periods during which no recruits make contact. Given that we wanted to minimise non-response from all possible sources, we sought information on whether there were specific days and times fishers would prefer to make contact, or if they would rather leave a message on a message service to request a call back for a more convenient time.

The focus group participants indicated they would prefer to leave a message and request a call back (56%), while 22% indicated they would like the survey phone line attended each day, or on weekends only (Figure 4.27). When asked about what times of the day they would what the phone line attended, 56% of focus group participants indicated a preference for after 6pm, while 22% opted for 1pm-6pm and requesting a call back (Figure 4.27).

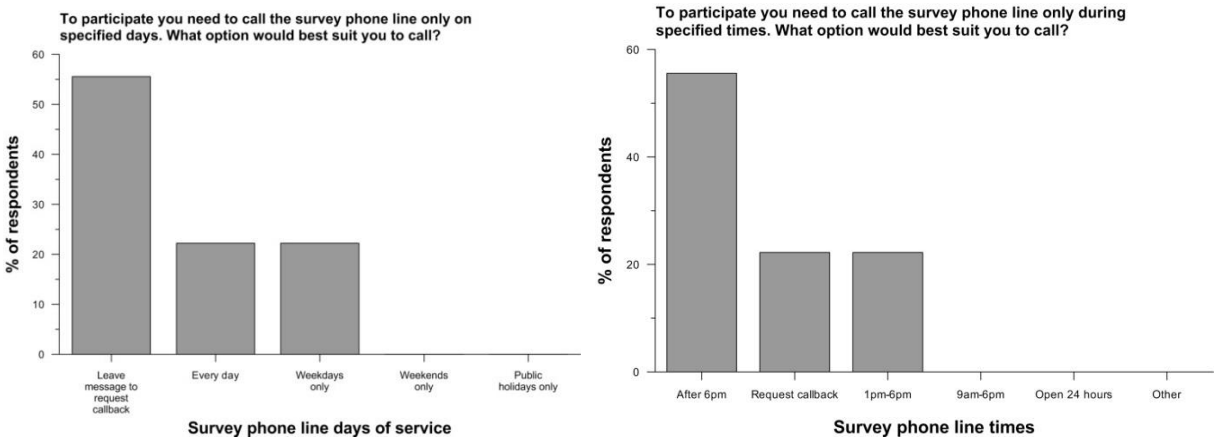


Figure 4.27: Responses from focus group participants regarding the days (left) and times (right) they would prefer to call a survey line to participate in the Tasmanian recreational fishing longline survey.

4.2.3.3 Providing confidential information to survey staff

In the March 2014 RDS technical workshop it was noted that the RDS survey should only include licence holders, since the RDS data would ultimately be compared against the licence frame 'population'. However, it was agreed that asking for a respondent's licence number may create the perception among fishers that the survey has a compliance objective, which may result in more sceptical fishers not wishing to participate. However, opening the survey to unlicenced fishers would potentially add significant cost to the survey, but most importantly, it may significantly bias the recruitment dynamics of fishers. Therefore, we decided to ask the focus group if they would still participate if their licence number was required to participate. Interestingly, 100% of respondents indicated they would still participate if they were required to provide their licence number to be eligible for the survey. As a result, the survey scope was restricted to licence holders only.

Similarly, there was concern that asking respondents for their full name and postal address may cause the more sceptical or suspicious coupon holders not to recruit to the survey. However, because it is impractical to conduct face-to-face interviews, there is a requirement to be able to post a respondent's rewards to an address. Of the focus group participants, 70% indicated they had no problem providing their full name and a postal address, while the remaining 30% suggested they would be more comfortable providing limited contact details such as a phone number and/or email address only. No participant indicated that they would prefer to remain anonymous, which is common case in RDS surveys of stigmatised populations.

4.2.3.4 Incentives for participation and recruiting peers

RDS has two incentives within its mechanisms, the first is an incentive offered for a respondent to complete an interview or questionnaire, and a second incentive is then offered for each eligible peer the respondent recruits to the survey. However, the incentive amount and type is a contentious issue among RDS practitioners and must be appropriate to the population being studied. In RDS surveys of female sex workers a cash incentive ($5-20) is offered, whereas clean needle/injection kits have been an effective incentive for intravenous drug users. Advice from RDS experts at the technical workshop was that the incentive should not be so low that it is not worth the respondent's time to participate, but should not be so high that the survey will attract ineligible subjects who may pose as eligible subjects. The general rule of thumb used in RDS surveys is that the initial incentive is equivalent of a reasonable meal at a local restaurant, and the collective value of the secondary incentive for recruiting eligible subjects should be similar to the first incentive.

The focus group was asked to record the value of the first incentive that they believe would be reasonable recompense for participating in the interview. Prior to asking this question a number of participants questioned why an incentive was being used and that they believed most people, including themselves, would participate even if no reward was offered. Interestingly, the focus group participants provided a wide range of inventive values for the first reward, ranging from $5 to $50, with 37.5% of participants believing that $45-50 should be offered. When asked to record the incentive amount for recruiting another eligible subject, 37.5% of participants believed that $5-10 would be an appropriate incentive, although suggestions of up to $150 per successful recruit were recorded (Figure 4.28).

After discussing the incentive value, the focus group was asked the type of incentive they would most prefer. It was explained that most government surveys would not be able to offer cash, but cash-like options are available such as cards for store credit (e.g. Woolworths card) and eftpos cards loaded with credit that can be used wherever eftpos is available. Other more common incentives were also proposed such as project-specific merchandise (e.g. t-shirts, caps, etc) and fishery-specific equipment (e.g. hooks, line, etc). The predominant response (78%) from participants was that a cash-like Eftpos card was the preferred incentive amount, followed by fishing equipment (11%) and project merchandise (11%) (Figure 4.28).

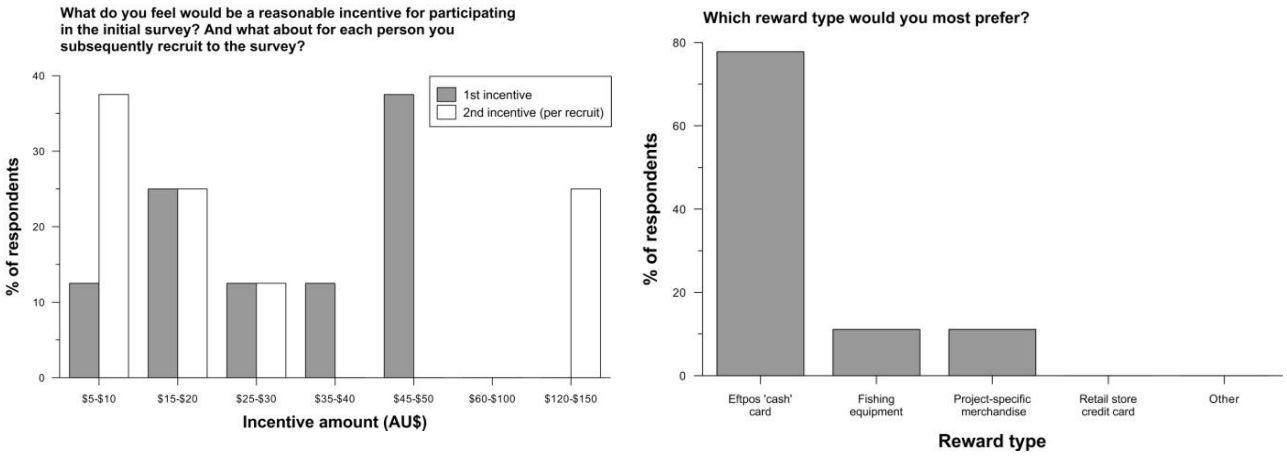


Figure 4.28: Responses from focus group participants regarding a reasonable incentive amount (left) and type (right) for participating in the initial interview in the Tasmanian recreational fishing longline survey.

4.2.3.5 Selecting eligible subjects and distributing RDS coupons

A key assumption of RDS is that the relationships between a recruiter and the peers they deem to be eligible for a survey are reciprocal. In this case, the recruiter and the recruitee must each know the other is a longline fisher from Tasmania. Therefore, it is important to determine a typical recruiter's definition of someone they 'know' personally. This information will help define eligibility questions in the formal RDS survey.

The concept of 'knowing' someone had a broad definition among the focus group participants. Most participants believed that the minimum amount of information required to 'know' someone is the ability to initiate a conversation (33%) or knowing the person's first name only (33%). Participants believed that a nickname (22%) and a full name (11%) were less important to define knowing someone. Encouragingly, participants did not consider recognising someone by sight or an internet username as 'knowing' them (Figure 4.29).

Following on from the concept of 'knowing' someone, we were interested in determining whether respondents would pass a coupon to a stranger, which would violate the assumptions of RDS since the stranger would not be included in the recruiter's estimate of degree size. In spite of the information provided by and to focus group participants relating to 'knowing' someone, 66% believed they would consider giving a coupon to a stranger and only 22% indicated they would follow the eligibility criteria and not attempt to recruit a stranger (Figure 4.29). Given this information, in the formal survey we would safeguard against recruitment of strangers by asking the coupon holder to provide the first name of the person from whom they received the coupon.

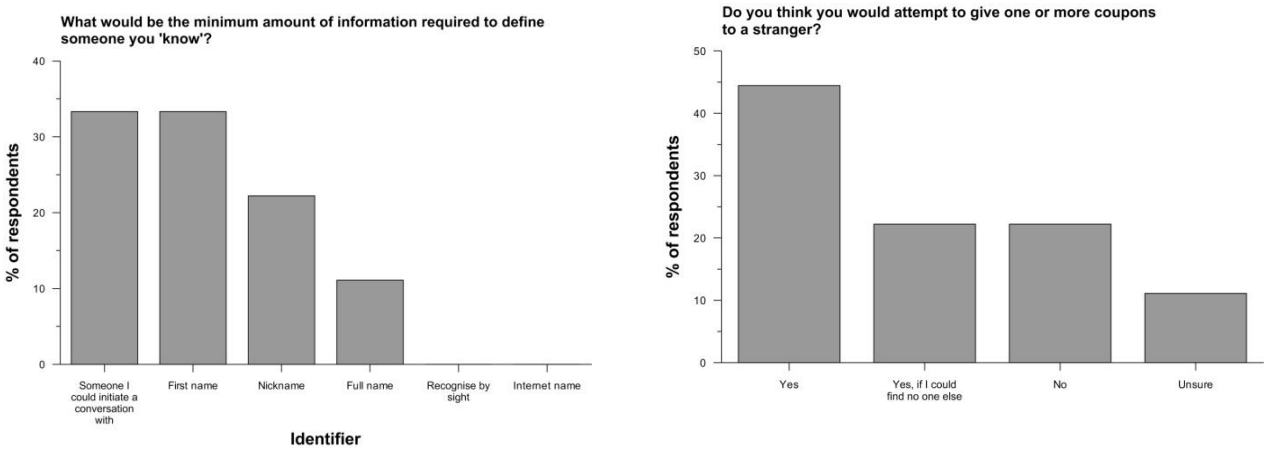


Figure 4.29: Responses from focus group participants regarding what they consider the minimum information needed to 'know' someone (left), and whether they would consider giving a stranger a coupon (right).

In most RDS surveys, each respondent is given a small number (1-5) of coupons to distribute to eligible peers. To ensure the momentum of the recruitment process is maintained, it is desirable to impose expiry dates on coupons to encourage recruiters to distribute coupons and recipients to redeem them. The expiry period should be long enough to provide a reasonable time for distribution and redemption, which will depend on the frequency that peers are in contact with each other.

The focus group participants estimated that it may take between 7 days and up to six months to distribute three coupons to eligible peers. The majority of participants believe they could distribute their coupons within 1-2 weeks (33%) and 1-2 months (33%). Given this information, it was decided that an expiry period of 3 months would be imposed on coupons in the formal RDS survey.

Figure 4.30: Responses from focus group participants regarding how long they estimate it would take to have three recruitment coupons accepted by eligible peers.

4.2.3.6 Estimates of personal degree (network size)

The most important piece of information that a researcher requests from each respondent in an RDS survey is the number of eligible peers the respondent may consider passing a coupon to. This self-reported estimate of their degree, or social network size, is used in the final RDS analyses to correct for differential recruitment bias that can result when one group (e.g. fishing club members) have larger social networks of eligible subjects than another group (e.g. non-members).

There can be several interpretations by respondents of what constitutes a social network. In the context of the Tasmanian set-line fishery survey, the broadest interpretation is anyone whom a respondent knows who fishes with a longline in Tasmania. However, the strength of social ties can vary markedly between each individual. This means that although a respondent may 'know' each person in their social network, they may not consider all subjects suitable to pass on a coupon. In using degree estimates to weight samples in RDS surveys, we are in fact interested in the number of subjects who have a non-zero probability of selection by the respondent.

The focus group participants reported a wide range of degree sizes from 2 to 100, although 56% estimated knowing 4-6 eligible longline fishers (Figure 4.31). By contrast, the effective RDS degree – that is the number of subjects that a respondent would consider passing a coupon – was significantly lower with 56% of participants estimating that they would consider passing a coupon to only 1-3 eligible peers (Figure 4.31).

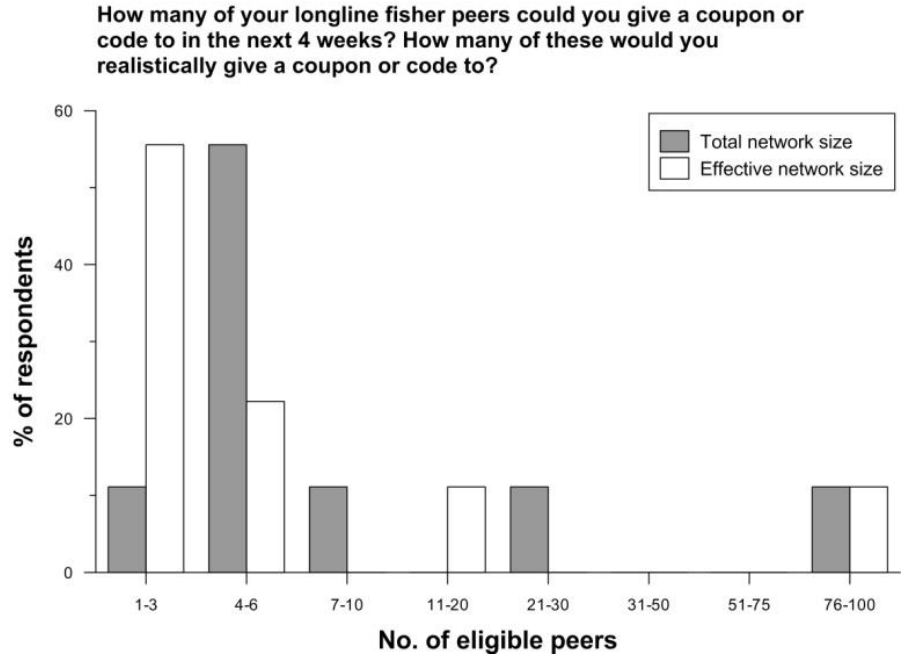


Figure 4.31: Responses from focus group participants regarding estimates of their total degree (or network size) and their effective degree of eligible longline fishers.

4.2.4 Key workshop outcomes

The focus group workshops undertaken at Devonport and Hobart provided great insight into the spatial and temporal dynamics of the Tasmanian recreational set-line fishery, and the immediate behavioural responses of fishers when presented with scenarios that would arise in a real respondent-driven survey of the fishery. The workshops not only improved our confidence in technical aspects of the survey, it also provided an ideal opportunity to invite eligible fishers to nominate them to be 'seed' respondents for the formal RDS survey.

The key outcomes to the workshop that would assist us in refining out survey design were:

- The majority of recreational longline fishing occurs across the north half of the state year-round, with the peak in fishing activity occurring between November and March.

- Recruitment coupons looked like a legitimate invitation, rather than a scam, but they should not be too 'busy' with graphics. Only provide the key information and be the size of a bank note that can fit into a standard wallet.

- If telephone is the primary means of contact with survey staff, the survey line should be a free call, with a message left for a call back at a time that is convenient to the respondent.

- Providing personal contact information (telephone number and postal address) and a fishing licence number was considered unlikely to deter eligible fishers from participating in an RDS survey.

- Incentive for participation in the interview and recruiting other eligible fishers was suggested to be $15-45 and $5-10, respectively, in the form of a 'cash-like' card.

- 'Knowing' someone to invite into the survey was considered to be someone a respondent would feel comfortable to initiate a conversation with, or someone known to the respondent by their first name.

- Despite rules being defined that coupons cannot be passed to a stranger, most fishers believed they would attempt to recruit a stranger.

- Most fishers had an effective degree of less than six eligible fishers that would take up to two months to recruit by preferring to pass a physical coupon face-to-face.

4.3 Tasmanian recreational set-line fishery field trial

The full complement of seed respondents had completed the questionnaire by 7 November 2014 and had received their recruitment coupons within the following 7 days. A total of 27 coupons were issued during the study, yielding only three respondents from the six seeds. All participants were male and ranged in age from 29 to 68 years. No individuals attempted to participate in the survey more than once, or to impersonate an eligible subject.

The first respondent was recruited to the survey on 17 November, followed by the second respondent on 26 November. Both of these respondents were recruited by the same seed. No further respondents were recruited to the survey until 9 January 2015, from a different seed, and no further respondents were recruited to the survey over the next four months. This prompted the early termination of the survey on 5 April 2015, after a total survey period of 5 months.

All three respondents were recruited into the survey using the paper coupons, rather than electronic transfer of the codes. Two of the respondents reported being recruited by a good friend, were both fishing club members and fished with a longline in a friend's boat. The third respondent was recruited by an acquaintance, was not a fishing club member, but owned his own boat. All 9 survey participants generally fished with two or more fishers.

Several seeds reported a degree of six or more, with some being up to 100, in the focus group workshops. In contrast, the same seeds completing an identical questionnaire provided significantly smaller degree sizes of less than 4, with the maximum being just 10.

After all coupons had expired, respondents were attempted to be contacted for a follow-up survey to better understand their experiences with the survey. Only two respondents—coincidentally the only two respondents who recruited at least one fisher—were successfully contacted and participated in the interview. Both respondents passed their coupons to their peers' in-person and indicated they had no problem having all three coupons accepted. Both indicated there was "obvious scepticism" from peers when offering coupons and explaining the research objectives.

4.4 Tasmanian recreational rock lobster fishery field trial

4.4.1 RDS recruitment

Following phases one and two of seed recruitment, a total of 36 seeds received 114 coupons. After one month, only two respondents were recruited from the coupons distributed by the first 20 seeds. Following completion of our wash-up survey we received two more call backs in March 2017, making a total of four responses since commencing sampling. These were the only responses we received from phases one and two of seed recruitment before the expiry of the coupons on 31/5/2017. All four responses originated from two seeds in the first recruitment phase (Figure 4.32), though, one of these did not utilise the telephone survey system as it occurred opportunistically with a dive club president while organising a phase 2 seed recruitment event.

A third seed and final recruitment event was conducted between April and June 2017. An additional 7 seeds were recruited with 21 coupons distributed. These seeds were given coupons with an extended deadline (20/07/2017). During the additional time, we received only one response.

In total, we were contacted by five coupon recipients, all from southern divers, with one being a second degree (2°) wave recruit (i.e a recruit by a recruit)(Figure 4.8). With the failure of the sample to progress past the second wave of an apparently highly connected population, it was concluded by project staff that RDS was unlikely to be able to recruit the required number of respondents for the sample to reach equilibrium, and thus a representative sample. Therefore, the study was terminated on 20/07/2017.

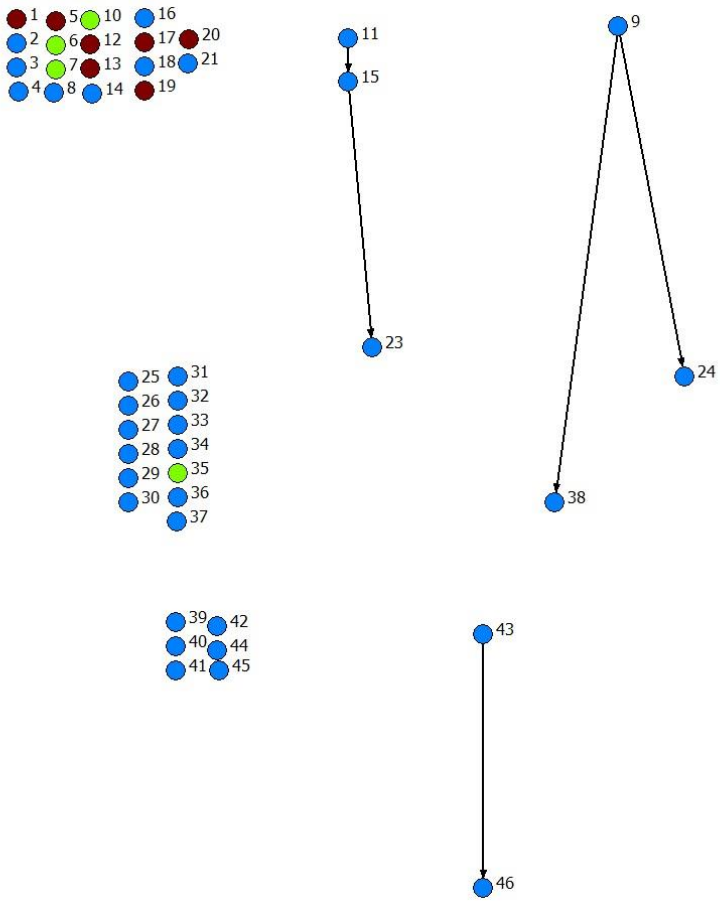


Figure 4.32: Chain diagram illustrating the failed recruitment process of the RDS survey within the Tasmanian recreational rock lobster fishery across the time period of the study. Blue nodes are divers, brown are potters and green predominately use rings but all bar one also used pots as well. Numbers and positions relate to the phase of seeding (first phase at the top, second in the middle and third at the bottom), if a recruit occurred from a seed there are moved to the right, with the time taken for their recruits to respond and the relationships between seeds described by the arrows.

Overwhelmingly the rock lobster seeds said that they primary motivation for completing the survey was to 'help research' (Fig 4.33).

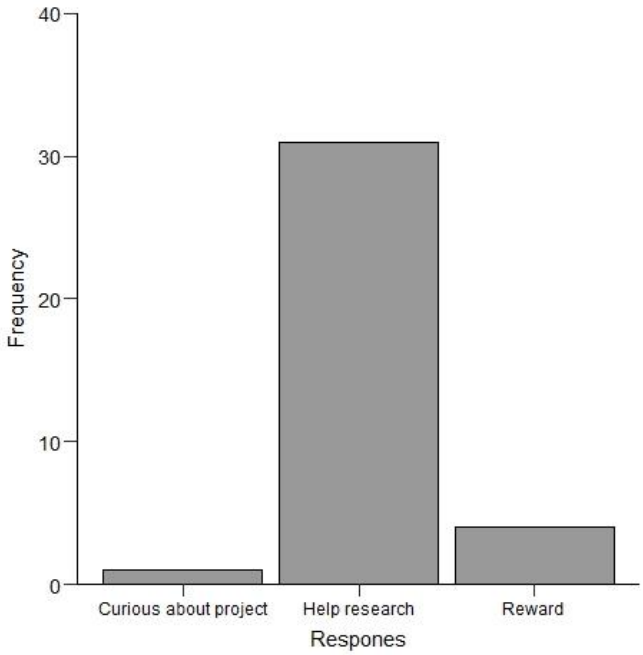


Figure 4.33: Reasons given from a list of why the seed was interested in participating in the research

4.4.2 Socio-economical data

Despite the failure of the experiment to validate the RDS methodology, the study was able to collect economic data from the 46 respondents. However, the results should be viewed with caution since the sample cannot be considered representative of the population.

The overall amount spent on each lobster fishing trip was similar between dive and non-dive fishers ($200-300) but there was some variation between methods with divers spending more on average on boat running costs and potters on consumables such as bait (Fig 4.34). There was also considerable variation between individuals.

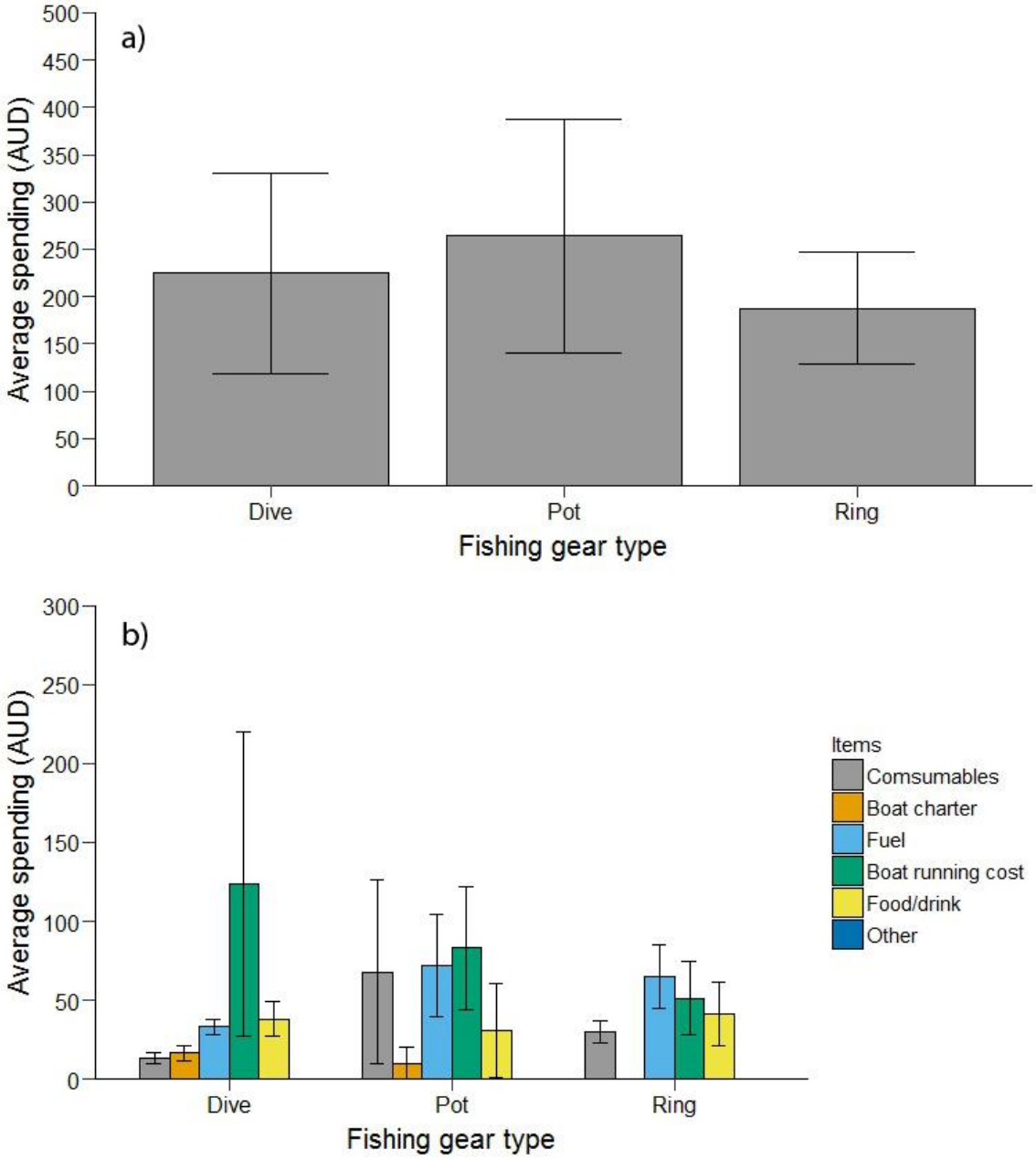


Figure 4.34: (a) Average spending per lobster fishing trip reported by fisher using each gear type. (b) breakdown of trip expenditure by category of spending.

Average annual spending for lobster fishing, when compared to spending on all forms of fishing showed that lobster fishing was less than a third for all methods (Fig. 4.35). Spending on fishing could be high with potters spending on average $10,000 per year on all forms of fishing. When this spend was broken down, captial items purchased by a few of the potters (i.e new boats, motors) was the driver of the larger spend for this group.

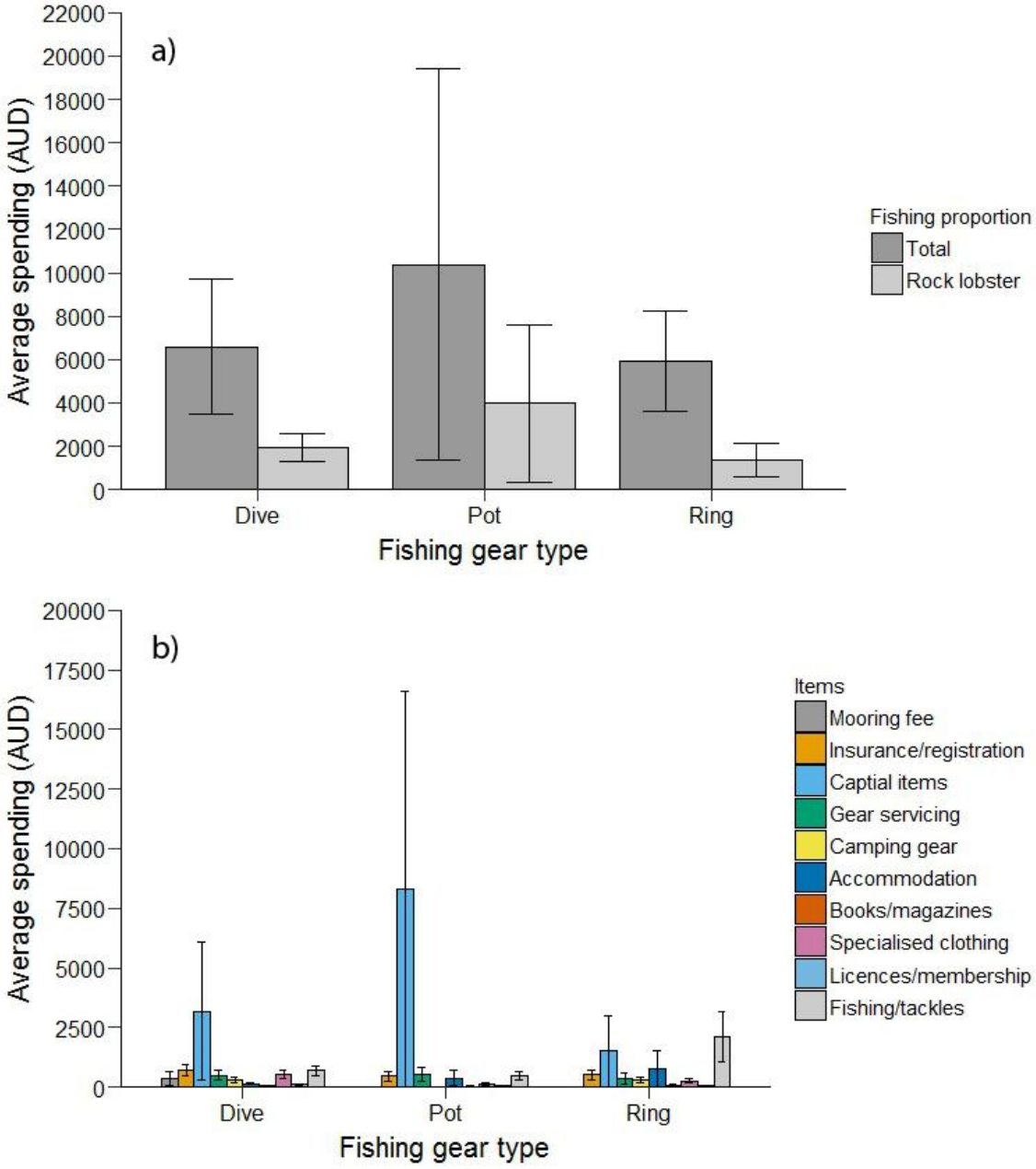


Figure 4.35: (a) Average spending per annum by recreaitonal rock lobster fisher using different gear type on all fishing activities (dark grey) and rock lobster specfic fishing (light grey). (b) breakdown of total annual expenditure by category of spending.

We found that on average recreational fishers spent much more landing a lobster (~$200 - $1000) than the price of purchasing a lobster (~$50-$100). This was partidcually so for the SCUBA divers (Fig 4.36).

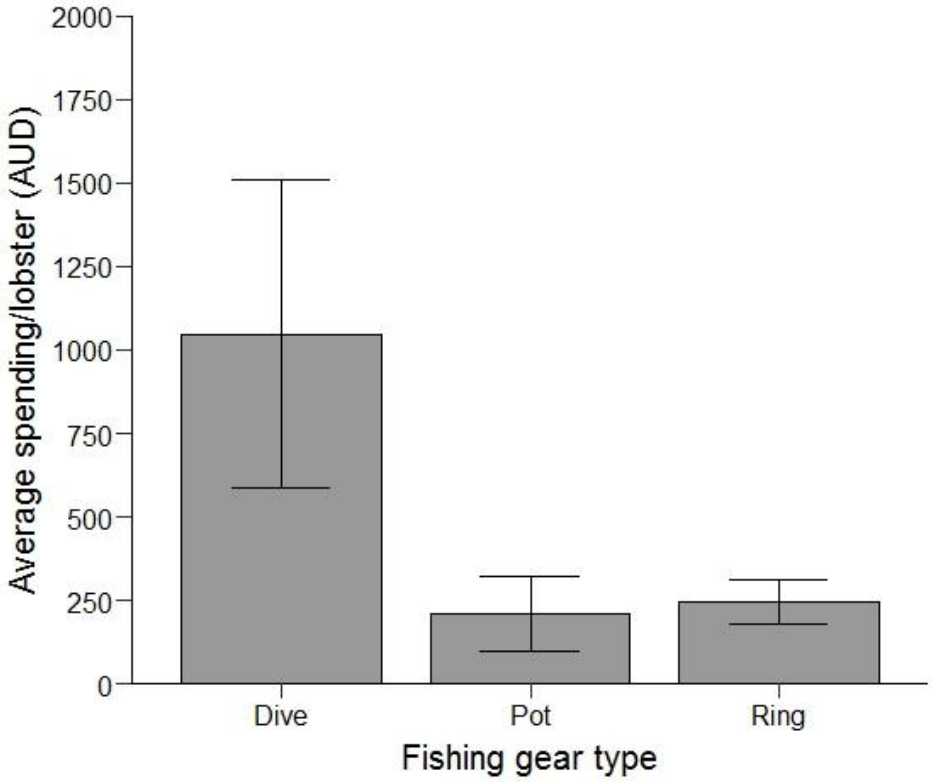


Figure 4.36: Average (± SE) expenditure per lobster caught by recreational rock lobster fishers using different gear types.

4.4.3 Follow up survey

The first round wash up survey was conducted on 24th and 27th February 2017, 5 weeks after the initiation of the project. Of the 20 initial seeds, 16 (80%) responded to calls and participated in the wash-up survey. Most seeds (n=11) successfully handed out coupons to peers, with 8 seeds (66%) handing out all three coupons (Fig 4.37). Based on this result, at least 28 coupons were in circulation within the recreational rock lobster fishing community, with 12 coupons distributed in the north and 16 in the south.

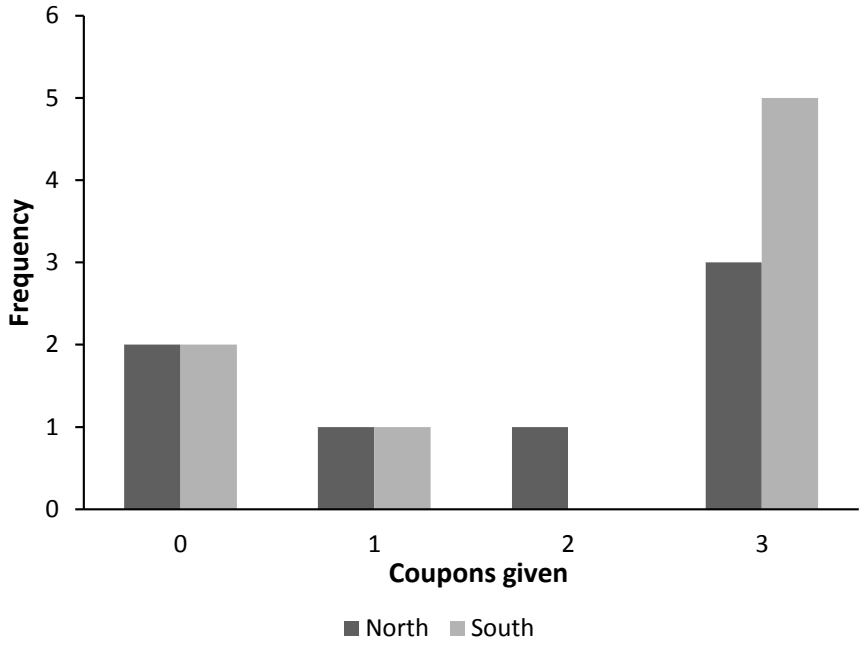


Figure 4.37: Number of coupons distributed by seeds from different geographical region (North= dark grey, South=light grey).

All seeds contacted suggested there weren't major difficulties in explaining the project to their peers and handing out coupons, with most ranking it as extremely easy (n=7) (Fig 4.38). The primary reason that seeds provided for not distributing their coupons was that they had other commitments and were generally too busy (n=3). One seed had had misplaced the coupons.

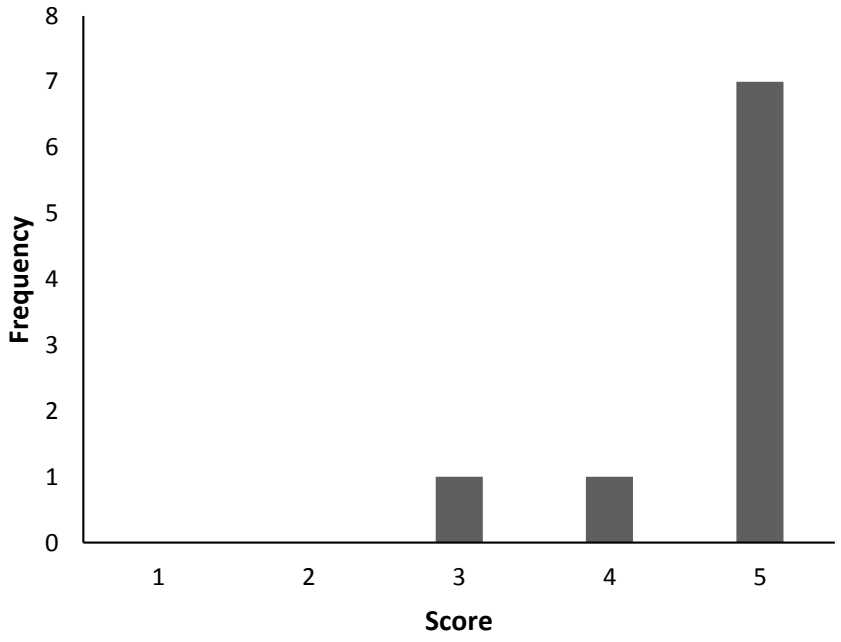


Figure 4.38: Difficulty score for handing out coupons 1 = very challenging, 5 = very easy

Most seeds suggested they handed out coupons within one week of completing their questionnaire (Fig 4.39).

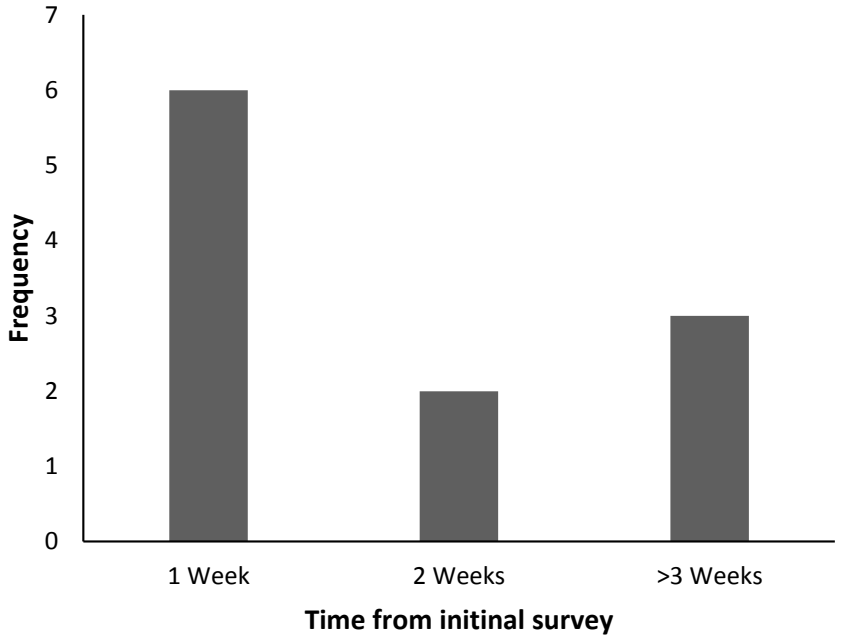


Figure 4.39: Time taken by individual seed to distribute coupons to peers.

Given the failure of the RDS approach to recruit a sample of Rock Lobster fishers the decision was made not to undertake the scheduled, designed and ethics-approved validation survey from the licence frame list.

Discussion

5.1 ESP Pilot study

Our ESP results demonstrated the efficacy of RDS to access a diverse sample of subjects of a non-stigmatised but otherwise motivated population, even when they represent components that are very rare within the population. For example, staff representing USC and UQ comprise only 0.12% and 0.84% of the ESP population, yet RDS was successful in accessing 100% of these staff. However, this is not to say that RDS is certain to sample all minority groups within a population in all cases. Successful recruitment of minority groups relies on members of the group being socially connected to the wider population and the absence of high homophily (i.e. within-group affiliation) of other groups in the population. High homophily can lead to recruitment 'bottlenecks' in extreme cases and reducing the probability of recruitment of members of other groups because the recruitment process finds its way into particular groups within the population from which recruitment cannot escape and eventually ceases (Johnston et al. 2013; McCreesh et al. 2011; Rudolph et al. 2011). For example, Toledo et al. (2011) found that recruitment of heavy drug users in Rio de Janeiro developed bottlenecks through fear of some groups to interact with other groups, which biased the sample and terminated recruitment chains prematurely.

High homophily for the agency characteristic at ESP may have been partly responsible for none of the six GU staff being recruited to the study. However, given that GU represented only 0.7% of the population, the probability of any sampling method of encountering these staff is low. This is illustrated in **Error! Reference source not found.** where a random sample from the census data failed to account for EHP staff that also comprised 0.7% of the population.

5.1.1 Speed of recruitment

The speed of recruitment in the ESP survey was rapid with an average of 13 respondents per week, effectively being recruited from a single viable 'seed' respondent from 18 waves over 15 weeks. This recruitment speed to attain the 197 recruits may at first appear far slower than what has been documented for most RDS surveys conducted on hard-to-reach populations. For example, Malekinejad et al. (2008) reviewed 123 RDS studies conducted between 2003 and 2007 and found that most studies take less than ten weeks to recruit 200-300 subjects. However, many of these studies attained their sample from up to ten successful seeds, rather than one like in the ESP study. Not all surveys of hard-to-reach populations are as rapid as the studies reviewed by Malekinejad et al. (2008). For example, it took Rudolph et al. (2011) three years to recruit 357 illicit drug users from 46 seeds and12 months to attain a sample of 391 from 28 seeds.

Recruitment speed is largely a function of the frequency of interaction between peers, which in many cases is related to their geographic proximity to each other (McCreesh et al. 2011). The rapid per-seed recruitment in the ESP survey was facilitated by respondents primarily recruiting peers who were in close proximity to their workstation or had face-to-face contact at a frequency that was less than the expiry period of the coupons. Placing these results in the context of a recreational fishery, it would be expected that the recruitment of fishers distributed across a large geographic scale (e.g. Tasmania) would be significantly slower than at ESP as their frequency of person-to-person interaction is likely to be lower, and their proximity to each other is likely to be larger. Abdul-Quader et al. (2006) found that physical isolation of groups was the largest impediment to recruitment among drug users in New York. Although the authors note that recruitment was possible across broader geographic area, there was a strong tendency for respondents to recruit peers from within close proximity of the recruiter's residential postal code.

An emerging characteristic of specialised recreational fishers is that they are increasing proficient with modern electronic technologies such as smart phones (Baker and Oeschger 2009; Hartill and Edwards In Press) and are connected in some capacity to other specialised fishers through social media and online discussion forums (McPhee et al. 2002). Using these platforms, fishers share information on a variety of factors such as recent catch reports, productive fishing locations and techniques, and environmental conditions (e.g. sea surface temperature). Therefore, in the context of applying RDS to these specialised fisheries, the traditional impediments to coupon transfer and recruitment speed posed by geographic distance and physical contact may be greatly reduced, and may even expedite the recruitment process by allowing recruitment to be facilitated through these platforms in addition to traditional paper coupons. In an email-based application of RDS ("WebRDS"), Wejnert and Heckathorn (2008) attained their desired sample size of 150 respondents in just 72 hours. Although the survey was expedited by the respondent self-administering the questionnaire, which is normally done during an appointment with a researcher, the study demonstrates the advantage of utilising alternate avenues to facilitate recruitment. Some further considerations are necessary for implementing online and telephone RDS surveys, such as accounting for duplication or impersonation of subjects, and delivery and relinquishment of coupons. If solutions are found to these issues, an 'e-RDS' approach may further reduce labour and operating costs and increase the speed of RDS surveys applied to specialised recreational fisheries.

Although the recruitment speed at ESP was slowed due to the remaining six seeds failing to progress past the third recruitment wave, this benefitted the survey outcomes by developing long robust recruitment chains that penetrated deep into the sociometrics of the ESP population to access even rare

components of the population (Wejnert and Heckathorn 2011). In the ESP study, it was desirable for us to not intervene in the recruitment process to document the natural expansion and eventual termination of the recruitment chains. However, if a similar situation arose in a formal survey of recreational fishers, as it did for the Tasmanian recreational rock lobster survey, it is advisable to continue to introduce new seeds until a number of seeds showed positive signs of recruitment chain expansion. This would ensure that the overall RDS sample expands more rapidly and would serve as a safeguard that the survey may still be able to reach the desired sample size and access the rarer components of the population should a recruitment chain from a particular seed suddenly terminate.

5.1.2 Degree estimates and impacts on RDS estimators

One of the major, and possibly limiting, assumptions of RDS is that respondents are able to accurately recall their degree, that is, number of eligible subject whom they 'know'. The ability of respondents to accurately recall degree is a key input parameter for most RDS estimators to correct for differential recruitment bias, that is, the sample being biased towards particular groups within a population characteristic (e.g. males vs. females) having larger social networks that result in them having a higher probability of recruitment. Previous RDS studies have dealt with the estimation of degree size in different ways, such as asking respondents about how many people they know in the target population, or the asking how many eligible people they know in a specified time period in an attempt determine the likely number of people a respondent would actually pass an RDS coupon to (e.g. Wejnert 2009). However, respondents can often have different interpretations of what constitutes an eligible subject than researchers (McCreesh et al. 2012). The period for which recall of an eligible sample of subjects is also important as recall bias is likely if respondents are expected to recall the number of eligible peers they have interacted with over a long period of several months or years (Bernard et al. 1984; Brewer 2000; Butts 2003).

In the ESP study, respondents were asked to estimate their degree within the ESP population in three different ways to estimate their: "extended degree", "immediate degree", and "reverse degree" (see Section 0). Our results indicated the number of people respondents know at ESP (extended degree) was generally around twice the number of people respondents would actually consider giving a coupon to (immediate degree). This highlights the need to be explicit in the wording of degree questions in order to provide the most accurate data for use with RDS estimators.

In the follow-up survey we assessed the reliability of "immediate degree" estimates of respondents by asking the same question as in the original survey. For all agencies, the mean recalled immediate degree estimates was around 30% higher than the original mean immediate degree estimates. We believe this may be due to respondents being able to reflect on their original estimate between surveys. The mean "reverse immediate degree" estimates were substantially lower than the mean "recalled immediate degree" estimates, but interestingly, they were roughly similar to the original mean "immediate degree" estimates. We believe that the immediate degree estimates may have the potential to incur an 'egocentric' bias, since the wording of the question places the respondent in the control of who they think they could convince to accept a coupon. Conversely, the "reverse immediate degree" is psychologically different in that it places the respondent on the outside of a large group who possess coupons and have the control of who those coupons can be offered to. As a result, we believe respondents are probably more realistic in estimating their number of reciprocal relationships, rather than the number of people whom they could *persuade* to accept a coupon. We feel the "reverse immediate degree" may serve to fulfil two important assumptions of RDS; to provide an accurate estimate of a respondent's degree, and that reciprocal relationships exist between all peers included in a respondent's network.

Although the reverse immediate degree may be a less biased degree estimator, the precision of the estimates is unknown. This has been a contentious issue among RDS researchers since degree is such an important parameter in RDS estimators that determine the prevalence of particular population characteristics (Bengtsson and Thorson 2010). Lu et al. (2012) found that underestimates of degree caused by forgetting or rejecting peers among a network of homosexual men resulted in only a small difference in the mean absolute standard error using the RDS-II estimator, so long as the recruitment

chains are sufficiently long to represent the sociometric breadth of the population and obtain a large enough sample size to attain convergence of the sample strata. However, when one demographic group rejected half of the recruitment invitations (i.e. reducing the effective degree), while another group accepted all invitations, the bias in the RDS estimator and error was large. This substantiates the suggestions of Gile and Handcock (2010) that the greater the systematic difference in degrees between groups, the greater the potential bias in population estimates, rather than differences in the absolute degree estimate by each respondent.

Such differential degree bias may occur in recreational fisheries, for example between novice and experienced fishers when asked to recall the number of people they know who fish for a particular species (e.g. Southern Bluefin Tuna) or with a particular gear type (e.g. longline). Experienced fishers may have a clearer idea of the fishing activities of their peers due to more frequent fishing-related interactions, and may more accurately report their degree. In contrast, a novice fisher may have less knowledge of the specific habits of their peers and include any peer who is a fisher, rather than a specialised fisher in question, and thus their degree may be overestimated.

There are two ways to possibly minimise this bias in future studies. The first is by clearly and explicitly defining an eligible subject, which may involve a series of broad questions that become increasingly specific. For example, if the researcher wishes to know how many people the respondent knows who have caught a Southern Bluefin Tuna in the past twelve months, it may be best to ask: How many people do you know who would have fished in the past twelve months? Of these, how many are sport fishers? Of these sport fishers, how many would target Tunas? Of the Tuna fishers, how many do you know of who have caught a Southern Bluefin Tuna ? This line of questioning can allow respondents to better visualise and adjust their estimates at each stage. However, depending on the time frame in question, these estimates may still be biased by recall ability.

The recent suggestion to improve the accuracy of degree estimates is to incorporate a line of questioning that relates to quantifiable metrics with respect to the population of interest using approaches such as the ‘scale-up method’ (Killworth et al. 1998) and other model-based variants (McCormick et al. 2010). McCormick et al. (2010) demonstrated that network size and inherent uncertainty could be estimated by asking respondents how many people a respondent knows in the USA who gave birth in the past twelve months, and how many people they knew having a particular first name (e.g. Michael). Because the number of these metrics is known, the number of people known to give birth or having a particular first name is proportional to the overall population. Therefore, a respondent who knows three women who gave birth knows about one millionth of the total US population using official birth records. With the addition of several other similar questions, responses can be modelled to produce degree estimates that are generally more precise and less affected by recall bias. This approach may be applicable to specialised recreational fisheries by using a range of questions specific to the fishery, for which there is a known number, such as “How many people do you know who currently hold a fishing licence in Tasmania?”.

5.1.3 Population prevalence estimates and RDS validation

An important outcome of this study was our ability to validate RDS by comparing the population prevalence estimates produced by the RDS estimators with the true population, as characterised by ESP staff census data. As discussed in previous sections of this report, sampling and non-sampling biases such as differential recruitment, recruitment bottlenecks, degree estimation by respondents, and non-response have the potential to significantly affect population prevalence estimates. Although several studies have attempted to undertake sensitivity analyses on simulated populations to assess the impacts of potential biases in RDS estimators (Gile et al. 2014; Goel and Salganik 2010; Lu et al. 2012), only two other RDS studies (McCreesh et al. 2012; Wejnert 2009) have undertaken a ‘gold standard’ validation studies on real populations. Wejnert (2009) implemented a non-traditional form of RDS using purely electronic means (“WebRDS”), while McCreesh et al. (2012) compared population parameters obtained by RDS for a Ugandan village population with census data of the same population.

The ESP RDS validation study demonstrated the efficacy of RDS to access the full spectrum of population characteristics, including sampling individuals from the rarest population strata. From the RDS sample, the three RDS estimators produced mean population prevalence estimates that were generally not markedly different to what could be obtained using traditional probabilistic simple random sampling of the census dataframe. We found that the unadjusted RDS sample (i.e. the RDS crude estimator) generally produced the most accurate mean population prevalence estimates, being within 10% of the actual population prevalence for the three primary characters of agency, building level and gender. The RDS-II and Gile's SS estimators produced almost identical mean population prevalence estimates across all population characteristics and in many instances estimates were no different to the crude estimator and hence within 10% of the actual population. However, both estimators did not perform as consistently as the crude estimator across all population characters. For example, with respect to building level, RDS-II and Gile's SS estimators produced mean population proportions of staff on level G that were 25% and 30% higher than the crude estimator.

In the cases where substantial overestimates or underestimates were observed, the confidence intervals were also large, often greater than 100% of the population estimate. This would pose a problem if data from these estimators were being used at face value in the absence of census data to expand data collected from respondents on a particular parameter to the population. Take for example, a hypothetical situation where a researcher wished to estimate the total catch of Gummy Shark in Tasmania. The researcher recognises that the Gummy Shark fishery is highly specialised and the catch rates differ substantially by fishers who longline, rod and reel and handline. The researcher uses RDS to obtain population proportion estimates of people who fish with a longline, rod and reel and handline so that the appropriate proportion of fishers can be recruited to a 12-month diary survey. If the mean proportion of longline fishers is 50% (± 50), and the mean annual catch per fisher is 100 (± 0) fish, the catch estimate will range between 0 and 10,000 fish.

There appeared to be a systematic bias in the estimates produced by the RDS-II and Gile's SS estimators, in that if the crude RDS estimate for a particular population characteristic was higher than the actual proportion, then estimates from the other two RDS estimators were even higher again than the crude estimate. The reverse was true for the RDS-II and Gile's SS estimators when the crude estimator produced values lower than the actual proportion. The instances where the largest departure of RDS-II and Gile's SS mean proportion estimates from the actual proportions occurred also had the largest variance, as well as the high homophily vales. For example, RDS-II and Gile's SS produced the smallest variance for gender where homophily was 1.14, and high variance for both building level and agency, which had large homophily values of 3.30 and 2.75. These results probably arose because the RDS-II and Gile's estimators have underlying assumptions that the social network structure of the population is not clustered and has only weak homophily among the population characteristics being assessed (Gile and Handcock 2010).

These results highlight the need for careful real-time monitoring of the RDS sample as it develops in order to identify significant departures in homophily. Although we aimed to allow the recruitment process to develop organically at ESP with no intervention to test the performance of RDS against the theory, building level and agency would have been two key characteristics to monitor since they contain significant physical and social barriers to recruitment. Where departures from homophily were detected, we could have intervened to steer the recruitment process to underrepresented population components by offering additional incentives to recruit underrepresented groups, terminate chains that were recruiting overrepresented groups, or introduce additional seeds that represent the underrepresented groups. Intervention is common during the recruitment process of RDS studies to allow the sample to be directed towards something that is more representative of the population based on either previous research or the researcher's experience. Such intervention is sometimes needed because RDS, left unattended, does not generally recruit in ways that conform to the strict assumptions defined in RDS theory. This has led to criticisms that RDS to produce representations of 'psuedo-populations' rather than the true populations (Mantecon et al. 2008). However, our pilot study suggests that RDS estimators can produce population proportion estimates that are similar to the actual population, but there is scope for improvement. We advocate the need for further research to develop

RDS estimators that can account for the natural variations in RDS recruitment processes, rather than rely on researchers to intervene in various ways to manipulate the recruitment towards what they believe is the actual population structure. Gile and Handcock (2015) have recently developed a model-assisted estimator that may go some way to addressing these issues.

5.2 Field trials of RDS in specialised recreational fisheries

5.2.1 Tasmanian recreational set-line fishery trial

In this first trial of RDS in the Tasmanian recreational set-line fishery it appears that the genuine need for the research, which did not involve any management changes, was not adequately conveyed by seeds and early respondents of the survey. This is a disappointing outcome given the significant investment in resources to understand the fishery, the behavioural and attitudinal characteristics of the fishers, and the incentives offered.

During this trial, we did not intervene to manipulate the recruitment process, to motivate respondents to distribute their coupons, or to advertise the study to encourage participation in order to facilitate the recruitment process. The reason for this is that we aimed to document how the RDS recruitment process operates organically in relation to the RDS model theory. We did not want to introduce any potential sampling biases that may propagated through the sampling waves that would compromise the accuracy and precision of the population prevalence estimates. However, on reflection we may have had more success if we added more seeds to the survey. Determining a suitable number of seeds is often a contentious issue in RDS surveys. Researchers need to initiate the survey with enough seeds so that there is some insurance against some seeds not being successful, but not having too many and so generate only short recruitment chains, rather than a few long chains that recruit a diversity of subjects. In contrast, if a large number of seeds are used and they are all reasonably successful, the number of respondents will be large, the cost of the survey will be increased due to more incentives being paid and staff required to conduct interviews, but the length of the recruitment chains may be too short to obtain a representative sample from the population.

Most RDS studies use less than ten seeds (Malekinejad et al. 2008), although many of these studies are undertaken in large cities where the population density and recruitment by in-person contact are both high (Abdul-Quader et al. 2006). However, as RDS is being applied in increasing diverse settings, there is emerging evidence to suggest that many seeds should be used and particular seeds terminated after determining which chains are likely to flourish. For example, Rudolph et al. (2011) obtained over half of their sample of 357 illicit drug users in New York from only two seeds from a total of 46 seeds. Therefore, further applications of RDS to recreational fisheries may benefit from additional seeds.

Another method of stimulating recruitment in RDS surveys of recreational fishers is to perform follow-up calls with respondents to encourage them to distribute coupons. A similar approach is used for telephone diary surveys of recreational fishers to remind them to record data for individual fishing trips (Lyle et al. 2002). This approach has not been considered in previous RDS applications since respondents have generally remained anonymous.

Although we planned to undertake a comprehensive follow-up survey of RDS respondents, our sample size was too small to confidently determine the primary causes of recruitment failure and how they could be addressed in future. We gleaned some information from the two follow-up survey respondents and from conversations with seeds before the survey began. It appears that one of the potential impediments to recruitment is the social context in which the coupons are attempted to be passed between peers. Some respondents implied that it can be awkward to approach a peer and persuade them to accept the coupon knowing that the peer will soon learn that the recruiter will receive a reward for each successful recruit. As a result, some respondents may choose not to compromise the integrity of their relationship with their peer over a small financial gain. Similarly, respondents may feel some level of guilt or responsibility if they recruit peers who provide data that could be perceived as responsible for justifying the imposition of management restrictions on the fishery.

5.2.2 Tasmanian recreational rock lobster fishery trial

Similar to the set-line fishery respondent driven sampling (RDS) did not proceed as expected in the Tasmanian recreational rock lobster fishery, even in the context of dive-club memberships in what are likely to be highly connected communities. Learning from the experiences of our set-line fishery trial, we conducted repeated rounds of re-seeding and even steered the recruitment process towards those who responded (divers) in an attempt to stimulate recruitment. Unfortunately, these tactics resulted in little improvements in either the recruitment speed or the total number fishers recruited to the survey.

Our follow-up survey found that 66% of coupons had apparently been distributed by seeds. Those who had not distributed their coupons said this was mostly due to either forgetfulness or misplacing the documentation (i.e. recruitment coupon). We mailed out additional coupons to respondents who had lost their coupons and considered them as re-seeds. We received no indications that there were any difficulties or concerns with getting recruits to participate in the survey. We also received unsolicited assurances from those that had not distributed some or all of their coupons that they would endeavour to do so in the near future. If these assurances are true and respondent coupons had been distributed and accepted by their peers, it therefore appears that the main impediment of recruitment is for coupon recipients to simply call the survey's freecall number.

As our follow up survey for the rock lobster fishery found no reported impediments from the seeds to pass on their coupons we suggest a range of potential reasons for the RDS process failing past the first wave. During the project, three trials of RDS were conducted, and of these, the two recreational fishery trials were unsuccessful, while the non-fishery trial using ESP staff was successful. The difference in results may have been due to different motivations for participation. The primary motivation for staff in the ESP study were 'the reward', 'favour to a peer' and 'contribute to knowledge to staff well-being', where recreational fishers primarily participated 'to help research'. The population of ESP staff had been subjected to a common hardship of being part of a compulsory relocation to the new ESP building in Brisbane. This resulted in both social disruption and often much longer commute times, which were compounded by a lack of on-site parking. Such impacts provided a large and highly personal non-monetary motivation to participate in the 'Ecoscience Precinct Staff Well-being Survey'. Furthermore, ESP participants were physically located close together, which is similar to the many stigmatised populations that are the subject of the majority of RDS studies, with both proximity and shared experiences—especially if they are contentious—helping to forge social cohesion.

In contrast, the poor recruitment in the two fisheries surveys may be attributable to the lack of a major non-monetary motivation to participate and the larger distances between individuals. Perhaps recreational fishers are just not a community that has strong enough cohesion to be suitable for RDS? Rather, they may be a much looser collection of individuals or possibly small groups of friends, family and acquaintances? Recreational fishing also often involves travel to different non-urban sites and very little interaction with fishers outside of the immediate party and possibly at the boat ramp or jetties — although to some extent, targeting dive clubs should have reduced these effects. This is opposed to stigmatised populations that may coalesce, both through a feeling of solidarity but also physical locations such a health clinics or known aggregation locations. During the reseeding stages of the Tasmanian recreational rock lobster fishery trial, various dive clubs were contacted. While these dive club and societies suggested a certain level of connection between dive fishers, club meetings are often infrequent and have limited turnover in club membership, which may slow recruitment of fishers. Nonetheless, it is the high social connectivity between similar that is the underlying driver of the success of the RDS method for surveying hard-to-reach populations (Heckathorn (2010b). Perhaps our study has revealed that recreational fishers are in fact not as socially connected as it is generally assumed.

Another potential reason for RDS failure in the recreational fisheries could have been in part due to our methodology. As suggested by name, Respondent Driven Sampling is solely dependent on being respondent driven. In our surveys, the respondent needed to make a voice telephone call. Changes in the use of telecommunications, with a switch towards data and text, may have reduced the likelihood

of return calls. From our follow up survey it appears that our most common type of non-response appeared to be "I will accept a coupon, but will decide later if I wish to participate". In nearly all cases it appeared that this decision was not made before the expiry of the coupon or was made to not make the phone call.

A key planned output of the project was to have been a demographic and behavioural comparison of the data from RDS and the known target population (licence holders), the latter to be based on a probability (random) sample of licence holders contacted by phone and synthesis of key demographic information collected as part of licensing. However, as demographic analysis using the RDS technique requires long recruitment chains consisting of at least 6 waves to reach equilibrium and provide reliable prevalence estimation, we were not able to justify undertaking a random telephone survey for comparative purposes using our small sample of respondents.

Our limited economic data suggests that the recreational take of lobsters is highly valued, grossly exceeding the market price, with fishers spending hundreds to thousands of dollars for each landed animal. However, as this data may not be representative it should be only considered as an interesting aside to the main methods assessment focus of the study. Previous studies of recreational rock lobster fishing socio-economics have suggested that the fishery is highly valued (Frijlink and Lyle 2010).

We did, however, undertake modelling simulations of RDS sampling to explore potential biases in estimation (Appendix 8). The model looked at the effect of differential rather than random recruitment of respondents from their social network with equal likelihood. In a situation where recruitment is not random and non-preferential but rather is weighted, say towards preferential recruitment of avid fishing club members, substantial biases were modelled to be introduced to all RDS estimators. These types of recruitment issues are well known in RDS recruitment and are adjusted for 'on the fly' during the sampling process if recruitment appears to be heading towards a demographic composition that the researcher does not believe to be representative of the population. To do this, chains of recruits are truncated and additional seeds are distributed to better represent the population. This however assumes that the structure of the population is known by the researcher so they can guide the sampling towards a representative database. Unfortunately, the extent of differential recruitment in our RDS surveys of recreational fisheries was unknown as we did not acquire sufficient recruits to test this proposition.

Conclusion

The power of RDS to capitalise on the influence of peers to have other peers accept a coupon and recruit to a survey can also work in reverse, if negative connotations towards the objectives of the research begin to develop among the target population. Recreational fishers have historically been a very co-operative group of resource users, collecting and supplying various data type to researchers, often free of charge, for a range of purposes including understanding of: catch and effort (Lyle et al. 2002), social and economic dynamics of fishers (Pitcher and Hollingworth 2002), movement of fish through volunteer tagging programs (Gillanders et al. 2001; Sawynok and Sawynok 2014), and the biology and ecology of their key recreational target species (Griffiths et al. 2010a). Over the past decade however, there may have been an increasing reluctance by recreational fishers to provide data for research due to fears that this may result in restrictions (Fry and Griffiths 2010; Griffiths et al. 2005).

In the face of widespread declines of many species due to the apparent overexploitation by recreational fisheries in recent years (Cooke and Cowx 2004b; Lewin et al. 2006; McPhee et al. 2002), recreational fishers have become increasingly proactive in demonstrating their support of conservation measures that can ensure the sustainability of their fishery and the supporting ecosystems. However, the extent of what recreational fishers are prepared to forego in their contribution towards sustainability, is sometimes insufficient from a fishery manager's perspective to achieve sustainability. As such, data provided to researchers has occasionally been used to impose precautionary conservation measures that require a greater sacrifice than fishers are prepared to give.

As such, there is often a fluid relationship between fishers and researchers or managers as to the extent to which each party trusts the other that their stated intentions are genuine. Therefore, it is of paramount importance that researchers build trust with the recreational sector before undertaking research in order to increase the quality of data from cooperative research, but also to optimise the uptake of the outcomes of the research. Whilst this may be achieved in traditional research programs that may interact with a relatively small number of recreational fishers, it is more difficult with RDS. This is because the needs and objectives of the research are only conveyed to the seed respondents, and it is the responsibility of the seeds and subsequent respondents in the study to convey these messages when recruiting their peers. However, if the true intent of the survey is misinterpreted by members of the target population, then this can negatively impact recruitment success and quality of data reported by respondents who may then be primarily motivated to participate for the reward, rather than to contribute to the research needs. This highlights the need for well respected 'sociometric stars' to initiate the survey to convey the strong research messages that can be well maintained through many sampling waves to encourage participation (Wejnert 2009).

For surveys of understood populations, which are urban, cohesive and motivated to engage with researchers, guided RDS sampling may be useful for gaining insides into behaviours, perspectives or outcomes. However, if the desired metrics are demographic and meant to be indicative of the total population, the population is unknown, distributed and not motivated through stigmatisation or some other issue, then RDS may be difficult to implement successfully.

Project materials developed

Section	Product name	Attached location
ESP Pilot study	ESP recruitment coupon	Figure 3.1
	ESP café free beverage voucher (reward)	Figure 3.2
RDS focus group meeting	Focus group questionnaire	Appendix 1
	Focus group consent form/ answer sheet	Appendix 2
Tasmanian recreational set-line fishery field trial	RDS-Recfish Manual	Appendix 3
	Seed recruitment letter	Appendix 4
	Seed factsheet/ information brochure	Figure 3.4
	Fisher recruitment coupon	Figure 3.5
	EFTPOS reward card	Figure 3.6
	Follow up reward information brochure	Figure 3.7
Tasmanian recreational rock lobster fishery field trial	Survey questionnaire	Appendix 5
	Seed recruitment letter	Figure 3.8
	Seed factsheet/ information brochure	Figure 3.9
	Fisher recruitment coupon	Figure 3.10
	EFTPOS reward card	Figure 3.11
	Follow up reward information brochure	Figure 3.12
	Wash-up survey questionnaire	Appendix 6
Modelling of RDS	RDS and Differential Recruitment	Appendix 8

Appendices

Appendix 1. Focus group annotated questionnaire

Tasmanian Recreational Set-line Fishery Focus Group Survey administered at two workshops held in Davenport and Hobart, Tasmania on the 13th and 14th of August, respectively.

Q no.	Question
	First we'll ask you a few simple questions about yourself and your general fishing experience
Q. 1	Are you currently a member of a fishing club? **(Tick 1 box only)** a. Yes b. No
Q. 2	How many years have you been a recreational fisher? **(Tick 1 box only)** a. Less than 5 b. 5-9 c. 10-14 d. 15-20 e. More than 20
Q. 3	How many years have you fished with a recreational longline in Tasmania? **(Tick 1 box only)** a. Less than 5 b. 5-9 c. 10-14 d. 15-20 e. More than 20
Q. 4	In the past 12 months (since August 2013) how many days did you fish with a recreational longline in Tasmania? **(Tick 1 box only)** a. 0 b. 1-4 c. 5-9 d. 10-29 e. 30-50 f. More than 50

Q. 5	Where do you primarily fish with your recreational longline in Tasmania? **(Tick more than 1 box if required)** a. North coast b. Northeast coast c. East coast coast d. South east coast e. South coast f. West coast g. Northwest coast h. Islands i. Other_____
Q. 6	What months do you generally start and finish fishing with your recreational longline in Tasmania? **(Write answers in the spaces provided)** Write the month you start fishing _____ Write the month you generally cease fishing _____ Write the peak month of your longline fishing activity _____
	Ok, now we're going to talk about the new incentive-based survey method we will use for this project. There are many intricate components of the method that may seem strange to you, but we hope to capture your honest thoughts and feelings about these components so that we can implement the survey in a way that has the best chance of being successful.
Q. 7	Consider this scenario. You arrive home to see a letter addressed to you. You open it and find the survey coupon (as shown) with no other information. What is your initial reaction upon seeing the coupon? **(Tick 1 box only)** a. Assume it to be some type of scam and throw it away b. Junk mail selling something you are not interested in and throw it away c. Suspicious of what it's about but you keep it and call the number d. A legitimate voucher for something of value so you keep it and call the number e. Too much information on the card, so you throw it away f. Other _____
Q. 8	You are at the boat ramp and approached by another longline fisher you know by first name but only see a 2-3 times each fishing season. He offers you a coupon and says if

	you complete a short and simple fishing survey you can make easy money. What is your initial reaction upon being offered the coupon? **(Tick 1 box only)** a. Assume to be some type of scam and decline the coupon b. Advertisement for something you're not interested in so you decline the coupon c. Suspicious of what it's about but you accept it to make a decision later d. A legitimate invitation that you accept and plan to call the number e. Refuse the coupon because you never accept flyers from anyone f. Other _____
Q. 9	After reading the coupon you decide the study is relevant to you. The coupon states you need to call a phone number to participate. What option best reflects your thoughts? **(Tick 1 box only)** a. I'd only call if the call is completely free b. I'd call if it was the cost of a local call or free c. I'd call regardless of cost d. I wouldn't call, regardless of cost e. Other _____
Q. 10	To participate in the study you need to call the survey number only on specified days. What option would best suit you to call? **(Tick 1 box only)** a. Weekdays b. Weekends c. Public holidays d. Every day e. Leave a message for someone to call back at a time that suits me. f. Other _____
Q. 11	To participate in the study you need to call the number only during specified times. What option would best suit you to call? **(Tick 1 box only)** a. 9am-1pm b. 1pm-6pm c. After 6pm d. Open 24 hours e. Leave a message for someone to call back at a time that suits me. f. Other _____
Q. 12	Assume you are happy to call the survey line to enquire about participating, you call and are informed that you will be required to provide your full name, address and a contact number in order to receive your reward. You are told your details are strictly confidential, held by the CSIRO, and will not be passed on to a third party. What best describes your initial thought to providing your contact details? **(Tick 1 box only)** a. No problem, the reward has to be sent somewhere b. I'd participate if I was only required to provide limited personal details c. I would only participate if I remain completely anonymous d. Other _____

Q. 13	In this survey, each participant is given two rewards; one for participating in the interview, and a second for recruiting other eligible fishers. I want you to think about the 1st reward. What would be the *minimum amount* that you would expect for what you are required to do. That is, call the free 1800 survey line and participate in a 15 min interview. **(Write answer in the space provided)** a. Enter amount here in whole dollars $_____
Q. 14	Still thinking about the 1st reward, what would be a *reasonable amount* that you would expect for what you are required to do. That is, call the free 1800 survey line and participate in a 15 min interview. **(Write answer in the space provided)** a. Enter amount here in whole dollars $_____
Q. 15	Now I'd like you to think about the 2nd reward. This involves giving 3 coupons (or sending 3 coupon codes) to eligible longline fishers who you know personally. When each of your contacts participate in the survey, you will receive a reward for that person. How much do you consider a *reasonable* reward to be for each of these fishers? **(Write answer in the space provided)** a. Enter amount here in whole dollars $_____
Q. 16	Now, we've talked about reward value (e.g. $X for an interview). Now I'd like you to think about what type of reward you'd prefer. Government organisations cannot give cash, so what is the reward you would most prefer? **(Tick 1 box only)** a. A store card (e.g. Anaconda or Woolworths card for groceries, alcohol, fuel) b. Exclusive project related merchandise (e.g. set-line t-shirt, cap, stubby holder) c. Set-line specific fishing products (e.g. fishing line, hooks) d. An EFTPOS card. Like cash but used only at EFTPOS points e. Other _____
	In this next section of questions, we're going to talk about how you think you would most likely recruit your friends to the study if you were given coupons. Remember you have the option of giving a paper coupon to someone, or just giving them the coupon code and the survey phone number.
Q. 17	Between which months would be best for you to distribute coupons to other eligible longline fishers whom you know? **(Tick 1 box only)** a. Any months as I'm in face-to-face contact with my peers year round b. Any months as I'm in email/SMS/phone contact with my peers year round c. Only during the longline season. Which months? _____ d. Outside the longline season. Which months? _____ e. Other _____
Q. 18	Which method would you most likely use to recruit an eligible longline fisher to the study? **(Tick up to 2 boxes)**

	a. Give a paper coupon directly to the person and verbally explain the details b. Send a paper coupon directly to the person by the post with written details c. Phone the person and provide the coupon code and verbally explain the details d. Send the coupon code to the person via email with written details e. Send the coupon code to the person by SMS with written details f. Send the coupon code to the person via social media (e.g. Facebook, fishing forums) with written details g. Send the coupon code to the person by fax with written details h. Other _____
Q. 19	Now I'd like you to think of which eligible fishers would you most likely give your coupons to? **(Tick up to 2 boxes)** a. Those who I communicate with most often by phone b. Those who live closest to me c. Those I see in person most often d. No preference. I would select someone at random regardless of where they live or how I normally communicate with them e. Those who I communicate with most often by email f. Those who I communicate with most often by phone over social media (e.g. Facebook, fishing forums) g. Other _____
Q. 20	Now I'd like you to think of a person's personal traits that would encourage you to give them a coupon? **(Tick up to 2 boxes)** a. Those who are most likely to accept a coupon b. Those who are most likely to call the number and complete the survey c. Those who are passionate about the longline fishery d. Those who are passionate about fisheries research e. No preference. I would select each person at random regardless of traits f. Those who would benefit most from a reward g. Other _____
Q. 21	Do you think you would attempt to give one or more coupons to a stranger (i.e. someone you met for the first time)? **(Tick 1 box only)** a. Yes b. No c. Yes I would consider it but only if I could not find anyone to give the coupons to d. Unsure Briefly state why _____ _____ _____

Q. 22	If you were approached by a stranger who offered you a coupon and explained you could earn money, would you accept the coupon? **(Tick 1 box only)** a. Yes b. No c. Unsure Briefly state why _____ _____ _____
Q. 23	If we were to give you 3 coupons to give to your longline peers, how long do you think it would take to have all 3 coupons accepted (either given directly to people, or codes by sending remotely)? **(Tick 1 box only)** a. Less than 1 week b. 1-2 weeks c. 3-4 weeks d. 1-2 months e. Greater than 2 months
Q. 24	If we were to give you an unlimited number of coupons, how many of your recreational longline peers do you think you could get in contact with to give a coupon or code to (either in person or remotely) in the next 4 weeks? **(Write answer in the space provided)** Write the number here _____
Q. 25	How many of these longline fishers would you realistically consider giving a coupon to, or accept a coupon from you? **(Write answer in the space provided)** Write the number here _____
Q. 26	The basis of the RDS survey method is to understand social networks. We define people in your network as people you 'know'. What would be the minimum amount of information you'd consider necessary to define someone you 'know'. **(Tick 1 box only)** a. Full name (e.g. John Smith) b. First name only (e.g. Terry) c. Nickname (e.g. Sparrow) d. By sight

	e. Internet name (e.g. Top_Fisho_1973) f. Someone you could initiate on conversation with g. Other _____
Q. 27	By using the definition of someone you 'know' from the previous question, how many people do you 'know', and they know you, who are 18 years or older, live in Tasmania, and you know or suspect have been recreational longline fishing in the previous 12 months? **(Write answer in the space provided)** Write the number here _____
Q. 28	In this study, we have no interest in whether longline fishers hold a current set-line licence from a compliance viewpoint. We are simply describing the fishery and trialling the new RDS survey method. However, if in future surveys we restricted participants to licence holders for statistical reasons, would you still participate if you continue to fish with a longline? **(Tick 1 box only)** a. Yes b. No, as I probably won't purchase a set-line licence c. No, but will most likely purchase a set-line licence d. Unsure. Please state why _____ _____
	In conjunction with the new RDS method, we are considering developing a new statistical method for estimating the population size of specialised recreational fishers. This involves recording how many times the same individual is recorded in multiple surveys. We are considering running the project as a number of short surveys.
Q. 29	Consider this scenario. Six months ago you received a BLUE coupon, you called the phone number and completed the longline fishery survey. You received a reward for participating and the full reward amount for recruiting 3 other fishers to the survey. You are approached by a longline fisher who you know and he offers you a YELLOW coupon to complete a longline fishery survey. What would be your likely initial reaction? **(Tick 1 box only)** a. Decline the coupon as know you can only participate in the survey once b. Decline the coupon as someone else should have a chance of being involved c. Accept the coupon as you made easy money last time d. Decline the coupon as you couldn't be bothered completing the survey again e. Decline the coupon because it might be counterfeit as my coupon was BLUE f. Accept the coupon because you may be able to assist further in the research g. Other _____
Q. 30	Consider a similar scenario. Six months ago you received a BLUE coupon, you called the phone number and completed the longline fishery survey. You received a reward for participating. You successfully gave your 3 coupons to other fishers, but this time they

	were ineligible so you did not receive your 2nd reward. You are approached by a longline fisher who you know and he offers you a YELLOW coupon to complete a longline fishery survey. What would be your likely initial reaction? **(Tick 1 box only)** a. Decline the coupon as know you can only participate in the survey once b. Decline the coupon as someone else should have a chance of being involved c. Accept the coupon as you made easy money last time d. Decline the coupon because you felt that you should have received a 2nd reward e. Decline the coupon because it might be counterfeit as my coupon was BLUE f. Accept the coupon because you may be able to assist further in the research g. Decline the coupon as you couldn't be bothered completing the survey again h. Other _____
Q. 31	Consider another scenario. Six months ago you received a BLUE coupon, you called the phone number but we told you were ineligible because you didn't fish with a longline in the previous 12 months, since you only fished with a drop-line for blue-eye. Therefore, you did not receive a reward. Since then, you have fished with a longline and know you would now be eligible. You are approached by a longline fisher who you know and he offers you a YELLOW coupon to complete a longline fishery survey. What would be your likely initial reaction? **(Tick 1 box only)** a. Decline the coupon because I'm still upset about wasting my time last time b. Decline the coupon as I couldn't be bothered completing the survey again c. Decline the coupon as someone else should have a chance of being involved d. Accept the coupon because I didn't receive a reward last time e. Decline the coupon because it might be counterfeit as my coupon was BLUE f. Accept the coupon because I want my data to count in the research g. Other _____
	That completes the 'formal' written responses. We'd now like to open a general discussion on various aspects of the survey.
Q. 32	Earlier we asked a few specific questions about the ways you might recruit other fishers to the study. Let's discuss how you would likely discuss survey eligibility of potential peers you intend on giving a coupon to? Would you just state what's on the coupon? Would you just want to get rid of the coupon at any cost??? **Discuss your answers**
Q. 33	What potential problems can you foresee with the survey method we have proposed tonight?

	Write answers in the space provided and we can discuss them - Scamming - Set a precedent for paying fishers for survey participation - Create the perception that tax payers dollars are being wasted - No sign-on from fishers due to the 'pyramid scheme' perception - Create animosity among fishers if a peer didn't choose to give them a coupon

Appendix 2. Focus group consent form and answer sheet

Tasmanian Recreational Set-line Fishery Focus Group Survey Consent Form

The focus group meeting is drawing on the knowledge of recreational fishers to assist with designing the most appropriate survey to optimise the collection of high quality data from specialised recreational fisheries. During the focus group meeting we will ask you some general questions about your experience with the Tasmanian recreational longline fishery, and for your personal thoughts and feelings towards particular aspects of our proposed survey design, which involves rewarding respondents for participating in an interview and for recruiting other fishers to the survey. The session will take approximately 2 hours. You are free to leave the session at any time and you are within your right to refuse to answer any question. On completion of the survey you will receive a $50 reward in the form of an EFTPOS cash card, just like an ATM card, which can be used to make single or multiple purchases where EPFTOS cards can be used. You have 12 months to use the credit. However, we cannot provide the eftpos cash card for an incomplete survey.

First, we require your consent to proceed with your involvement in the focus group. Information collected during these meetings will not be reported in a way where you can be identified. The data will only ever be reported in aggregated form and will ultimately be held by the CSIRO. The content of the focus group and proposed handling and use of the data has been reviewed and approved by the CSIRO Human Ethics Committee in application 068/14. If for any reason you are not satisfied with the content or delivery of the survey, or the actions or behaviour of project staff, you can lodge a complaint with the CSIRO Human Ethics Committee (Cathy.Pitkin@csiro.au or 07 3833 5693). By signing below you are indicating that you understand these terms and give your consent to proceed.

Print full name _____

Signature _____

Date _____

The main survey will begin on 1 October 2014 and we will need 4-6 longline fishers to initiate the survey by giving out three coupons to their peers. You will be rewarded for completing the survey and for each fisher successfully recruiting to the survey from your coupons. Would you be willing to be one of these initial survey participants?

YES / **NO** (Circle one)

If yes, please complete the details below

Residential address: _____

Suburb: _____ Postcode: _____

Home phone number: _____ Best contact time: _____

Mobile phone number: _____

Tasmanian Recreational Set-line Fishery Focus Group Survey Answer Sheet

Participant's Name: _____ Meeting Location: _____

Date: _____

Q. No	Answers
Q. 34	☐ Yes **(Tick 1 box only)** ☐ No
Q. 35	☐ Less than 5 **(Tick 1 box only)** ☐ 5-9 ☐ 10-14 ☐ 15-20 ☐ More than 20
Q. 36	☐ Less than 5 **(Tick 1 box only)** ☐ 5-9 ☐ 10-14 ☐ 15-20 ☐ More than 20
Q. 37	☐ 0 **(Tick 1 box only)** ☐ 1-4 ☐ 5-9 ☐ 10-29

	☐ 30-50 ☐ More than 50

Q. 38	☐ North coast **(Tick more than 1 box if required)** ☐ Northeast coast ☐ East coast ☐ South east coast ☐ South coast ☐ West coast ☐ Northwest coast ☐ Islands ☐ Other_____
Q. 39	• Write the month when you **start** fishing _____ • Write the month you **stop** fishing _____ • Write the peak month of your longline fishing _____
Q. 40	**(Tick 1 box only)** ☐ Assume it to be some type of scam and throw it away ☐ Junk mail selling something you are not interested in and throw it away ☐ Suspicious of what it's about, but you keep it and call the number ☐ A legitimate voucher of some value, so you keep it and call the number ☐ Too much information on the card, so you throw it away ☐ Other _____
Q. 41	**(Tick 1 box only)** ☐ Assume to be some type of scam and decline the coupon ☐ Advertisement for something you're not interested in so you decline ☐ Suspicious of what it's about but you accept it to make a decision later

	☐ A legitimate invitation that you accept and plan to call the number ☐ Refuse the coupon because you never accept flyers from anyone ☐ Other _____
Q. 42	☐ I'd only call if the call is completely free **(Tick 1 box only)** ☐ I'd call if it was the cost of a local call or free ☐ I'd call regardless of cost ☐ I wouldn't call, regardless of cost ☐ Other _____
Q. 43	☐ Weekdays **(Tick 1 box only)** ☐ Weekends ☐ Public holidays ☐ Every day ☐ Leave a message for someone to call back at a time that suits me ☐ Other _____
Q. 44	☐ 9am-1pm **(Tick 1 box only)** ☐ 1pm-6pm ☐ After 6pm ☐ 24 hours per day ☐ Leave a message for someone to call back at a time that suits me ☐ Other _____
Q. 45	☐ No problem, the reward has to be sent somewhere **(Tick 1 box only)** ☐ I'd participate if I was only required to provide limited personal details ☐ I would only participate if I remain completely anonymous ☐ Other _____

Q. 46	• Enter amount here in whole dollars $_____
Q. 47	• Enter amount here in whole dollars $_____
Q. 48	• Enter amount here in whole dollars $_____

Q. 49	**(Tick 1 box only)** ☐ A store card (e.g. Anaconda or Woolworths card for groceries, fuel, etc) ☐ Exclusive project related merchandise (e.g. set-line t-shirt, cap, etc) ☐ Set-line specific fishing products (e.g. fishing line, hooks) ☐ An EFTPOS card. Like cash but used only at EFTPOS points ☐ Other _____
Q. 50	**(Tick 1 box only)** ☐ Any months as I'm in face-to-face contact with my peers year-round ☐ Any months as I'm in email/SMS/phone contact with my peers year-round ☐ Only during the longline season. Which months? _____ ☐ Outside the longline season. Which months? _____ ☐ Other _____
Q. 51	**(Tick up to 2 boxes)** ☐ Give a coupon directly to the person and verbally explain the details ☐ Post a coupon with written details directly to the person ☐ Phone the person and verbally provide the coupon code and details ☐ Email the coupon code to the person with written details

	☐ SMS the coupon code to the person with written details ☐ Send the coupon code to the person via social media with written details ☐ Fax the coupon code to the person with written details ☐ Other _____

Q. 52	**(Tick up to 2 boxes)** ☐ Those who I communicate with most often by phone ☐ Those who live closest to me ☐ Those I see in person most often ☐ No preference. I would select someone at random regardless of where they live or how I normally communicate with them ☐ Those who I communicate with most often by email ☐ Those who I communicate with most often via social media (Facebook) ☐ Other _____
Q. 53	**(Tick up to 2 boxes)** ☐ Those who are most likely to accept a coupon ☐ Those who are most likely to call the number and complete the survey ☐ Those who are passionate about the longline fishery ☐ Those who are passionate about fisheries research ☐ No preference. I would select each person at random regardless of traits ☐ Those who would benefit most from a reward ☐ Other _____
Q. 54	☐ Yes **(Tick 1 box only)** ☐ No ☐ Yes I would consider it but only if I could not find anyone to give the coupons to ☐ Unsure ☐ Briefly state why _____ _____ _____

Q. 55	☐ Yes **(Tick 1 box only)** ☐ No ☐ Unsure ☐ Briefly state why _____ _____ _____
Q. 56	☐ Less than 1 week **(Tick 1 box only)** ☐ 1-2 weeks ☐ 3-4 weeks ☐ 1-2 months ☐ Greater than 2 months
Q. 57	• Write the number here _____
Q. 58	• Write the number here _____
Q. 59	☐ Full name (e.g. John Smith) **(Tick 1 box only)** ☐ First name only (e.g. Terry) ☐ Nickname (e.g. Sparrow) ☐ By sight ☐ Internet name (e.g. Top_Fisho_1973) ☐ Someone you could initiate on conversation with ☐ Other _____
Q. 60	• Write the number here _____
Q. 61	☐ Yes **(Tick 1 box only)** ☐ No, as I probably won't purchase a set-line licence ☐ No, but will most likely purchase a set-line licence

	☐ Unsure. Briefly state why _____
Q. 62	**(Tick 1 box only)** ☐ Decline the coupon, you know you can only participate in the survey once ☐ Decline the coupon, someone else should have a chance of being involved ☐ Accept the coupon, you made easy money last time ☐ Decline the coupon, couldn't be bothered completing the survey again ☐ Decline the coupon, it might be fake as my previous coupon was BLUE ☐ Accept the coupon, you may be able to assist further in the research ☐ Other _____
Q. 63	**(Tick 1 box only)** ☐ Decline the coupon, you know you can only participate in the survey once ☐ Decline the coupon, someone else should have a chance of being involved ☐ Accept the coupon, you made easy money last time ☐ Decline the coupon, you felt that you should have received a 2nd reward ☐ Decline the coupon, it might be fake as my previous coupon was BLUE ☐ Accept the coupon, you may be able to assist further in the research ☐ Decline the coupon, couldn't be bothered completing the survey again ☐ Other _____
Q. 64	**(Tick 1 box only)** ☐ Decline the coupon, I'm still upset about wasting my time last time ☐ Decline the coupon, couldn't be bothered completing the survey again ☐ Decline the coupon, someone else should have a chance of being involved ☐ Accept the coupon, I didn't receive a reward last time

	☐ Decline the coupon, it might be fake as my previous coupon was BLUE ☐ Accept the coupon, I want my data to count in the research ☐ Other _____

Q. 65	☐ How you would likely discuss survey eligibility of potential peers you intend on giving a coupon to? Would you just state what's on the coupon? Would you just want to get rid of the coupon at any cost? _____ _____ _____ _____ _____ _____
Q. 66	☐ What potential problems can you foresee with the survey method we have proposed tonight? _____ _____ _____ _____ _____ _____

Appendix 3. User manual for RDS-Recfish: an online survey tool and database for Respondent-Driven Sampling surveys in recreational fisheries.

Background to the user manual development

Recreational fisheries are becoming an increasingly important component of Australian and global fisheries. Often considered a benign leisure activity, increases in the number of fishers and the sophistication and affordability of fishing tackle (e.g. electric reels), vessels, and electronics (e.g. sonar, GPS) have elevated the efficiency of recreational fishers and their impacts on fishery resources to near that of commercial fisheries for some species. Technological advances have also contributed to diversification of the recreational sector where increasingly specialised recreational fishers explore fishing grounds and target species that were once only accessible to commercial fisheries.

Researchers and fishery managers are now presented with two difficult situations. First, the increased pressure on resources by recreational fisheries needs to be considered in assessing long-term biological sustainability of target species. Second, increasing catches and economic investment by specialised recreational fisheries may justify demands by recreational fishers for a greater share of resources shared with commercial fisheries. As a result, there is increasing need for fisheries scientists to obtain representative data on the demographics and motivations of these specialised fishers, as well as the

effort, catch, and economic investment that is required as input for stock assessment and equitable sharing among resource users.

Unfortunately, obtaining representative data from specialised or out-of-frame components of recreational fisheries using traditional methods (e.g. boat ramp and telephone surveys) is expensive and often ineffective because these components of the fishery: 1) lack a complete sampling frame from which to recruit a representative sample of fishers to surveys, 2) are comprised of fishers who are too rare to intercept in the wider community, and 3) are spatially and/or temporally diffuse. Therefore, alternative cost-effective survey methods are required.

Respondent-Driven Sampling (RDS) is one of the few methods that may attain a representative sample from specialised recreational fisheries. RDS is a form of peer-driven chain-referral sampling designed by epidemiologists to obtain representative population estimates from hard-to-reach, hidden or stigmatised populations, such as intravenous drug users, HIV carriers, and sex workers. RDS works by eligible subjects receiving incentives for survey participation and recruiting other eligible peers, who then recruit other eligible peers, and so on. After weighting each subject's social degree and other known biases, RDS can generate representative population estimates for a hard-to-reach population.

Populations of recreational fishers have different behaviours and attitudes than populations of intravenous drug users for example. Consequently, the approach of implementing RDS in recreational fisheries also differs. This manual provides step-by-step instructions for implementing RDS surveys with the "RDS Recfish" online survey module developed by the CSIRO. At each step in the survey the manual provides a screen shot and an explanation of options for each survey question. The data generated by the survey tool is stored in an online database that can be later extracted and analysed using an appropriate statistical analysis package, such as RDSAT or RDS Analyst.

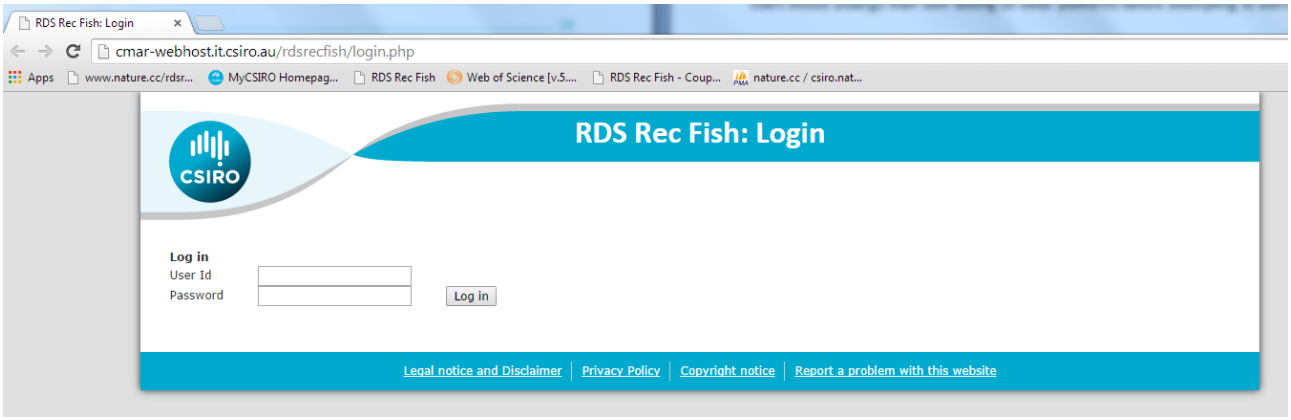
System requirements

The RDS Recfish survey tool is an online survey tool that allows multiple users across multiple locations to administer the RDS questionnaire and export data from a single database in real time. This is particularly important for geographically separated project staff to access the latest survey data to perform analyses, or to track the recruitment dynamics of the population in question and allow rapid intervention of the survey design if required.

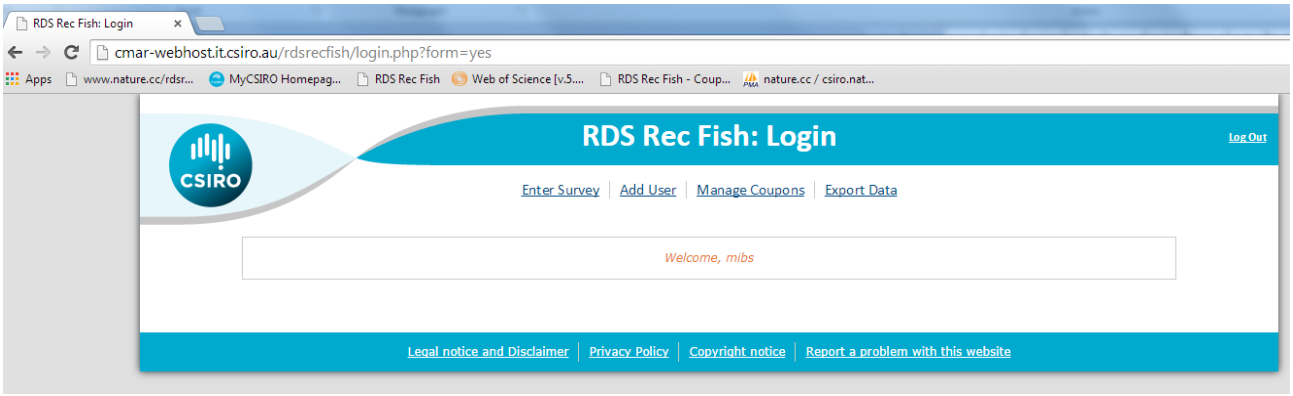
The survey acts as a standard web page where data entries are made by key strokes, or by selecting from pre-defined responses in drop-down menus. Although the survey can be viewed and administered on any web browser, it is recommended that the interviewer use the most recent versions of "Chrome" or "Firefox" software. The survey has undergone extensive testing both Mac and PC platforms using Windows XP and 7. Users should undergo their own testing on other platforms before attempting to administer surveys.

User registration

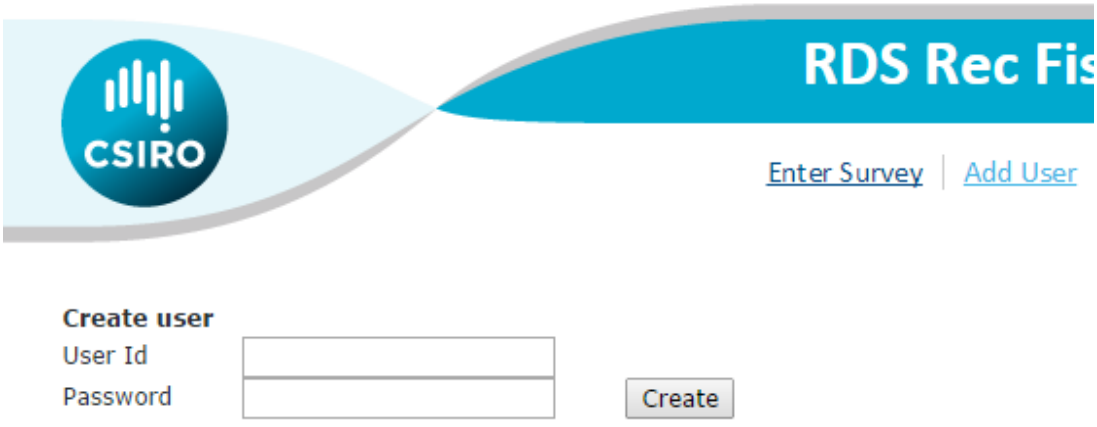
Before using the RDS Recfish survey tool each user must register with a User ID and password. This allows project managers to see who has created database records to enable follow up at a later point should data verification be required. To be added as a new user the survey staff member needs to log on and create an account. This can be achieved by accessing the survey website at http://cmar-webhost.it.csiro.au/rdsrecfish/login.php. The following will appear in the browser window.



The registering survey staff member will log on using their User ID and password and click Log in, which will reveal the window below.

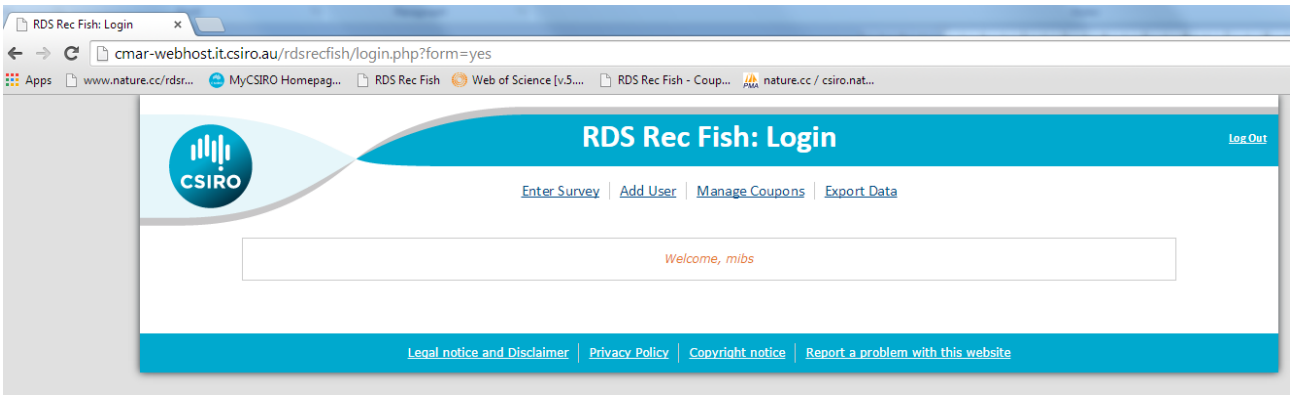


The registering survey member selects Add User, which reveals the screen below and allows the new user to define their personal User ID and password by entering their details and selecting Create.



Starting the survey

To start the survey, the user will need to go to http://cmar-webhost.it.csiro.au/rdsrecfish/login.php and log on using their new User ID and password. From the menu selection the user selects Enter Survey.



The survey tool is set up to enable the interviewer to easily navigate through the survey questions depending on the specific answers provided by the respondent. The survey is divided into three sections, each being a different background colour. The first section is dark yellow/orange and contains specific eligibility questions that allow the researcher to determine if the respondent is a legitimate member of the survey's target population. The subsequent blue section contains various questions under the heading Set-Line Fishing Data which relate to the demographic profile and fishing activities of the respondent. The last section of the survey is green and contains questions to collect contact details of the respondent in order to send their rewards and coupons, and to seek feedback on the survey and the fishery in general. The layout of the survey is split into four columns, *Click to Proceed*, *Questions*, *Respondent Answers*, and *Further Information*.

Click to proceed	Questions	Respondant Answers	Further Information
	Survey team member name	**mibs**	
Start survey			

The survey is now ready to be administered when a call is received on the Free Call 1800 survey line. The process for receiving calls in the present study is that a coupon holder will leave a message on the survey line of a suitable time and phone number to call on. A staff member calls the respondent at the requested time and conducts the interview, or calls back if contact was not successful.

To begin the survey click on Start survey. The script below should appear under the *Questions* column. All dialogue under the *Questions* column is to be read aloud to the respondent, except when prompts specifically inform you not to, or is not applicable.

Click to proceed	Questions
	Survey team member name
Start survey	Hello, you've called the CSIRO and IMAS Tasmanian recreational set-line fishery survey line. My name is mibs and I'll be assisting you today.

Question 2

The first question is to determine whom the interviewer is speaking with. This is mainly to build a rapport with the respondent and personalise the experience. When the phone is answered and it has been established that the respondent wishes to complete an interview, click on Question 2 .

Question 2	May I ask who I am speaking to?	

Type the respondent's name into the answer box. Once this is complete, question three will appear under question two (as in the image below), as the heading of that column suggests (*Click to Proceed*), left-click on Question 3 to bring up the next question. This process will continue for most questions in the survey, where the next question toggle will appear once the previous question is complete.

If the respondent opts not to provide their name simply type "NA" in the text box. Keep in mind that the respondent will need to provide their full name and address at the end of the survey in order for them to receive their reward and coupons to recruit other eligible subjects to the study.

Question 2	May I ask who I am speaking to?	John
Question 3		

Screening for eligible respondents

The next few questions are extremely important for RDS surveys as it determines whether the respondent is part of the target population and is eligible to participate in the survey. It is here that the interviewer needs to be aware of exactly what they are asking the respondent as this is the most probable point where a respondent may become upset if they are deemed to be ineligible. If ineligible, the respondent is instructed that they are unable to participate in the survey and will not receive the advertised reward. However, if a respondent is overly aggressive or it is perceived that the respondent may shed negative light on the project, it is at the discretion of the project leader as to whether the respondent may receive a small reward to diffuse the situation.

Determining eligibility is critical for an RDS survey as it is essential that there is no duplication of participants and that the respondent is a member of the target population, in this case, is a member of the longline fishery in Tasmania (Heckathorn 1997).

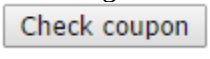
Identification of an Ineligible Respondent

If a respondent is ineligible to participate in the survey, the alert **INELIGIBLE** will automatically appear under the *Questions* column.

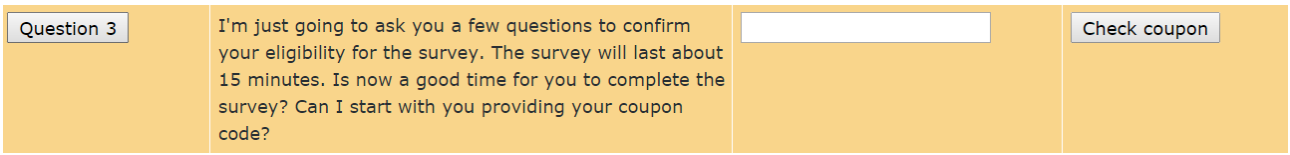
Under the "INELIGIBLE" alert is information that needs to be read out to the respondent explaining why they are ineligible to participate. Only text appearing between quotation marks ("") is to be relayed. The script will change depending on what stage of the screening process the respondent is deemed to be ineligible. Once the call has been terminated click on the 

button. It is important that even though a respondent may be ineligible, if they have a valid coupon code it needs to be recorded. **BEFORE** clicking the terminate survey button, record the reason why the survey was terminated in the comments box available above the terminate survey button. This step is important for other survey staff to distinguish why the survey was terminated, especially if the respondent presented a valid coupon code.

Question 3 – Entering a Coupon Code

Question 3 is where the coupon code is entered. The code is either hand written on a physical paper coupon, or passed onto the respondent by an eligible peer, either electronically (SMS, email, etc) or verbally. **<u>The coupon code is the most important part of an RDS survey</u>** as it is the respondent's key into the survey, and most importantly allows the researcher to track recruitment chains and facilitate specific statistical analyses *post hoc*. The respondent is only allowed to continue if they have a valid coupon code provided by an eligible respondent who has already been recruited into the survey. Read the script under the *Questions* tab. The 6 digit alphanumeric coupon code is comprised of 3 letters followed by 3 numbers. These 6 digits should be entered with no spaces. Double check the coupon code before clicking the 

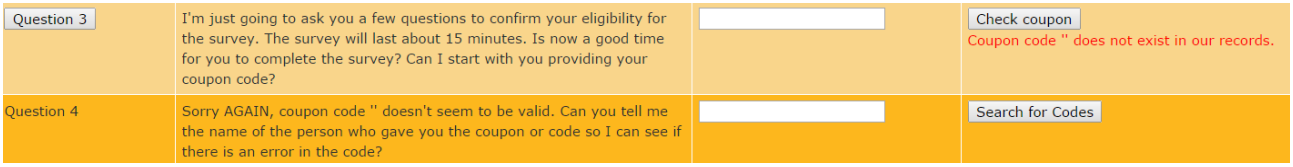
button.



If the respondent does NOT have a coupon code they are ineligible for the survey and the interview terminated. Follow the directions under the ineligible section (page 6). If the respondent has a coupon code there are two possibilities when entering the code: 1) the coupon code is valid and you will skip Q4 and go straight to Q5, or 2) the coupon is deemed invalid and Q4 will appear.

Question 4

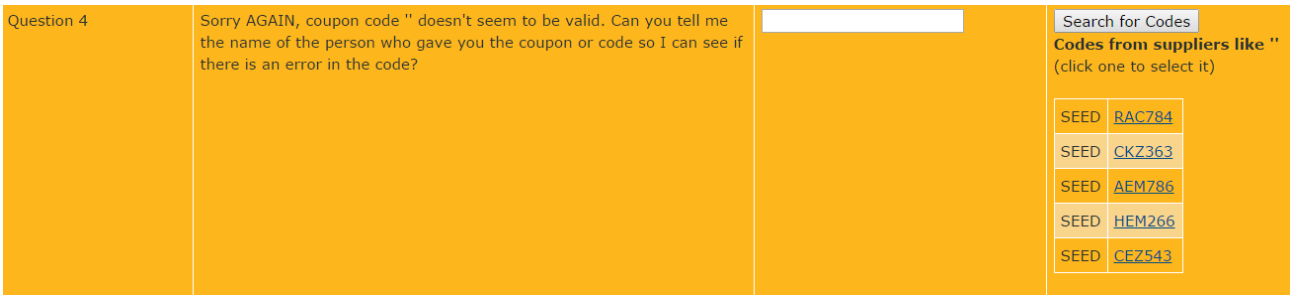
This step of the survey allows the interviewer to explore any misinterpretation or transcription errors of survey codes. This may be a particular problem if a respondent received the code by telephone or by electronic means. When a coupon code is not valid, read the script that appears under *Questions*. A strict eligibility criterion for an RDS survey is that the respondent received the code from someone they know and not a stranger. Therefore, the respondent should at least know the first name of their recruiter. The system will query the database for eligible participants matching a specified name (given and/or surname) and display the coupon codes relating to any matches. It is also important to determine whether the respondent is providing a nickname, for example using "Bob" for the name Robert.



If a person's name does not appear in the retrieved participant list the coupon code is deemed invalid and the survey must be terminated by following the steps outlined under ineligible (Page 6). However, every attempt should be made to search for variations in the spelling of names (e.g. Shane vs Cheyne) and common abbreviations (e.g. Bill vs William). Part of the script will advise the person to verify the code with their recruiter, or wait for a different eligible subject to issue them with a coupon.

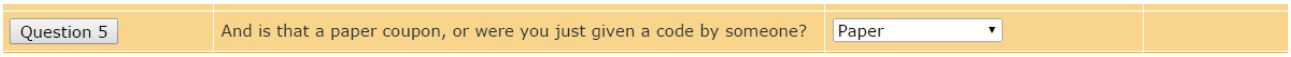
If the recruiter's name is valid a screen similar to the one below will appear and spelling errors or transcription errors can be explored (e.g. the letters O or Q may be confused with a zero). Select the correct code on the right-hand side of the screen and the survey will automatically update to question 5.

There may be instances where respondent have already participated and are attempting to participate a second time for financial reward. If possible, the interviewer should have the "Coupon Manager" (discussed later in this manual) screen open to quickly identify the coupon issuer. The interviewer may ask the respondent to verify the name of their recruiter. If there is suspicion, the interviewer should continue to ask whether the person has already participated and screen the person from the survey at this point. Alternatively, they may complete the entire survey and choose not to issue any further coupons to the respondent.



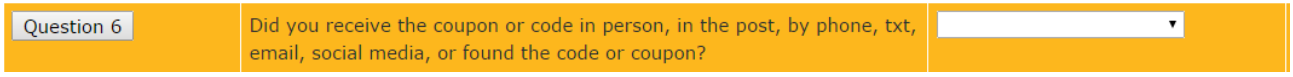
Question 5

This question seeks information on the mode by which the respondent received the code (e.g. by physical paper coupon, given the code, or assigned a 'seed' code by the researcher). Click on the downward arrow to select an appropriate response from the drop-down list. The purpose of this question is to determine the most effective method of coupon code transfer between peers.



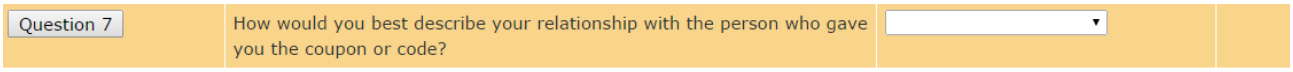
Question 6

Following on from Q5, Q6 determines the form in which the respondent received their code (e.g. a paper code in person or in the mail, given the code via SMS or an online forum). Click on the downward arrow to select an appropriate response from the drop-down list. The respondent cannot have found the coupon/ code, and these options will deem the respondent as ineligible as they had to have received the coupon or code from someone whom they know personally (see Ineligible, page 6).



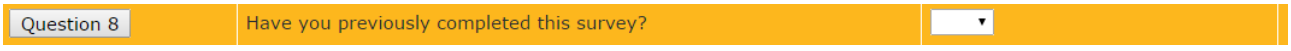
Question 7

This question establishes the respondent's relationship with their recruiter. A key assumption of RDS is that the respondent knows the person who provided the coupon or code, and that relationship is reciprocal. They cannot be a stranger. If the respondent received the code from a stranger they will be deemed ineligible and the survey will be terminated after reading the script that appears under the *Further Information tab* (see Ineligible, page 6).



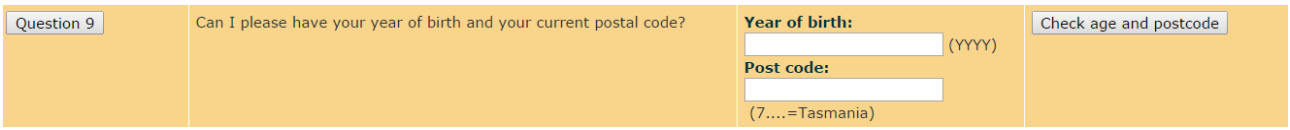
Question 8

Another assumption of RDS is that a member of the population can only participate once. Therefore, respondents need to answer "no" to this question or they will be deemed ineligible for the survey (see Ineligible, page 6). There may be instances where respondents have already participated and are attempting to participate a second time for financial reward. If they slipped through earlier questioning and answered "yes" to this question and the interviewer is suspicious, they should continue to complete the entire survey. If the name and or address of the respondent match another participant in the database then the interviewer should not issue any coupons to the respondent.



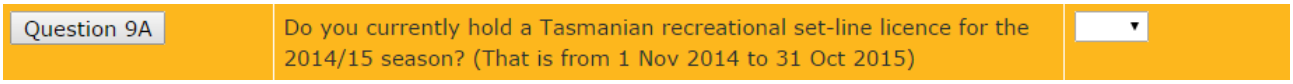
Question 9

This RDS survey is restricted to Tasmanian residents over the age of 18 years. Year of birth and post code of residence is needed to determine whether the respondent is eligible. If they are not they will be deemed ineligible for the survey (see Ineligible, Page 6).



Question 9A

Questions 9A and 9B are designed to determine whether the respondent holds a license for the 2013/14 and/or the 2014/15 set-line fishing season. This is critical information for the researchers to not only determine the eligibility of the fisher for the survey, but for the purposes of the current study, to be able to match the respondent to the set-line licence list held by Tasmanian Fisheries. This will help to compare the characteristics of respondents in the RDS survey with that of the known population of licence holders that we will sample at a later date using a telephone survey. Either response will bring up Q9B.



Question 9B

This question determines if the respondent held a license for the previous fishing season. If the respondent answers 'No' to Q9A and 'No' to Q9B they will be deemed ineligible for the survey (see Ineligible, page 6). Any other combination of answers will allow the respondent to progress to the next eligibility question.

Question 10

Longline fishers are the specific target of this survey. Longlining is licensed under the "set-line" fishery in Tasmania; however this license also includes the drop-line method. These methods are fundamentally different and are used to target very different species in very different habitats. The purpose of this question is to screen out drop-line fishers from the survey.

A drop-line is set vertically in the water column, set from a boat to the sea floor in deep offshore waters (100+ m) to target species such as blue eye trevalla. The line can have a number of hooks off it

and is often attached to electric reels. In contrast, a longline is set horizontally across the sea floor, with multiple snoods with hooks attached, generally with an anchor and a marker buoy at each end. They are generally set in much shallower water (10-50m) to primarily target Gummy Shark and Flathead. The answer needs to be “yes” to continue. The information that differentiates a dropline and longline needs to be explicit to avoid confusion and to prevent any drop-line fishers from entering the survey. If “no”, the respondent is ineligible (see Ineligible, page 6).

Question 10	In the previous 12 months have you fished, or intend to fish in the next 12 months, with a recreational longline in Tasmania? Specifically, a longline is set horizontally along the bottom with multiple snoods and hooks off it, as opposed to a 'dropline', which is set vertically from the surface to the bottom.	▾

Question 11

Once question 11 is reached the respondent is deemed eligible to participate in the survey. Read the dialogue that appears under the *Questions* tab to inform the participant of the survey aims and to gain their verbal consent to begin the questionnaire.

It is important that the respondent understands what is expected of them, what they will receive and how their personal information and response data will be stored and used. It is also important to inform the respondent that the survey has been approved by the CSIRO Human Ethics committee and where to direct complaints if they feel the survey or conduct of survey staff is inappropriate. If the participant answers “no” to this question they must not be coerced in any way to provide their consent. At this point the respondent is to be politely thanked for their time and the survey terminated as per the instructions given under ineligible (Page 6).

Question 11	Ok, I've been able to determine that you are eligible for the study. The study is drawing on the knowledge of recreational fishers to assist with data collection that can be used to improve opportunities in the Tasmanian recreational longline fishery. The survey will take approximately 15 minutes and I will ask you some general questions about your experience with the Tasmanian recreational longline fishery. On completion of the survey you will receive a $20 reward in the form of an EFTPOS cash card, just like an ATM card, which can be used to buy anything where EPFTOS cards can be used. You have 12 months to use the credit. You can also earn up to an additional $30 by referring other Tasmanian recreational longline fishers to this study, but I'll discuss that later. First, we require your consent to proceed with this survey. This information will not be used in a way where you can be identified. The data will only ever be reported in aggregated form and ultimately be held by the CSIRO. You are within your right to refuse to answer any question or to stop the interview at any time. However, I must advise you we cannot provide the $20 reward for an incomplete interview. Do you understand these terms and give your consent to proceed?	▾

Collecting fishery data

Set-line Fishing Data

Click to proceed	Questions	Respondant Answers	Further Information
Question 12			

Question 12

Read the dialogue that appears under the *Questions* tab to the participant. Question 12 is just an introduction to prepare the respondent about what types of questions to expect before asking specific survey questions.

Question 12	Ok, let's begin the survey. First let me first start by asking some general questions about yourself and then we'll talk about your longline fishing activities.	

Question 13

This question is NOT to be read to the respondent. Make a judgement, based on the sound of the respondent's voice as to whether the respondent is male or female and make a selection from the drop-down menu. There is also an option if gender cannot be determined. This can be changed at the end of the survey when the respondent's name is recorded.

Question 13	**DO NOT READ TO RESPONDANT:** By observation of voice, record if male or female	▾

Question 14

This question seeks information as to why the respondent decided to participate in the survey and may help in understanding the motivations of fishers to participate in the survey. The result could help determine an appropriate incentive or influence how the research needs to be promoted in future surveys. Select an appropriate option from the drop-down menu. The respondent also has the option of opting out of the question.

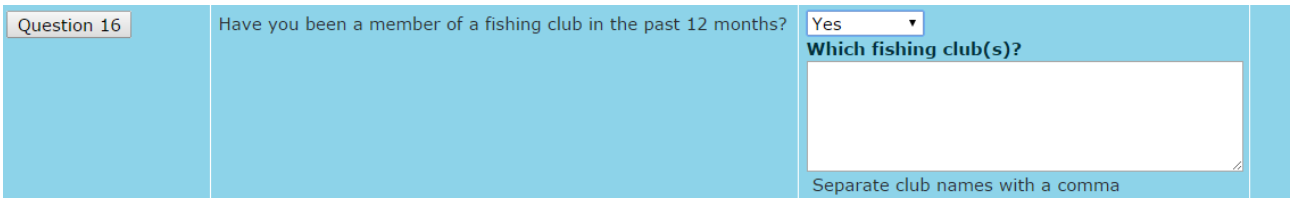
Question 14	What would you say was your primary motivation for participating in this survey about the recreational longline fishery?	▾

Question 15

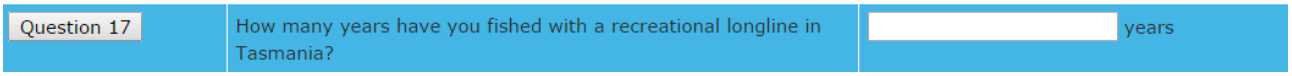
There is no question 15 following a database revision.

Question 16

Question 16 relates to whether the participant is a member of a fishing club. If they answer "no" go to Q17A. If "yes", a box under Q17 will appear where the fishing clubs can be specified. This information may contribute to the understanding of social connectivity between fishing club and non-fishing club members and be used as one of the characteristics to measure homophily of each group, that is, whether respondents from a particular group recruit peers similar to themselves.



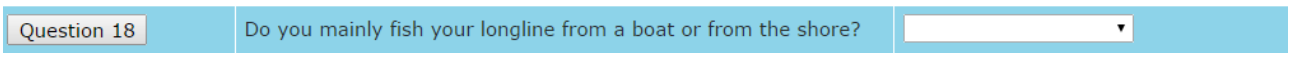
Question 17



This question seeks information on the relative experience level of respondent in the longline fishery. This may be an important factor for later stratification of the sample for RDS analysis.

Question 18

Question 18 seeks information on the mode by which the respondent deploys their longline. It is assumed that longlines are primarily deployed from a boat, but it may be possible that longlines are also set from the shore in particular regions. Select an appropriate response from the dropdown menu. The respondent also has the option of opting out of the question.



Question 19

This question seeks information on whether set-line licence holders own the boat from which the longline is deployed, or whether someone else (e.g. possibly an unlicensed fisher) uses the respondent's licence to fish legally. If the boat is owned by someone other than the respondent or their friend, select "other" and type a response on the text box (do not use quotation marks). The respondent also has the option of opting out of the question.

Question 19	Do you own the boat you mainly fish from with a longline or is it someone else's boat?	

Question 20

In the Tasmanian longline fishery, a licence is only required for the person who owns the longline gear. Therefore, it is legal for other fishers, or "spectators", to be in attendance and fish with the gear. In order to estimate fishing effort in future surveys it may be important to understand how many fishers are contributing to a unit of fishing effort. This can also give researchers an idea as to how many people could realistically be included in the longline fisher population, who would have been excluded using the eligibility criteria of holding a licence.

Question 20	When you go longline fishing how many people do you usually fish with? Just yourself or a few mates?	

Question 21

There is no question 21 following a database revision.

Question 22

There is no question 22 following a database revision.

Question 23

The next series of questions (Q23-25) relate to the composition of species caught in the Tasmanian longline fishery. This survey aims to characterise the fishery, so it's desirable to know which species are targeted by fishers, which species are actually caught by the gear, including bycatch species, and which of the bycatch species are returned to the water alive. Tick appropriate boxes next to the common names of species used in the fishery. Multiple species can be selected, and species not on the list can be added in the text box when "other" is selected.

An issue that may arise with this question is if a dropline fisher has slipped through the eligibility screening process. If the participant is only listing species that appear in the last grouping (highlighted in yellow), then they may not be a longline fisher. The fisher can be asked again to describe their gear and what depths they set at to better determine if the respondent is a dropline or longline fisher (see Q10). If the participant is believed to be a dropline fisher make note of this in the interviewer comments box at the end of the survey (page 19). When you reach Q47 DO NOT read all the dialogue under the Q*uestions* tab, as you will NOT issue the respondent with coupons to recruit other fishers. The respondent will still receive the initial reward for participating in the survey.

Question 24

The main difference between Q23 and Q24 is that Q23 lists the target species, while Q24 lists the species that the respondent actually catches with their longline. These species will comprise target species, byproduct (incidentally caught, but retained), and bycatch (incidentally caught but not retained). Q25 will determine which of these species are bycatch species. Tick appropriate boxes next to the common names of species used in the fishery. Multiple species can be selected, and species not on the list can be added in the text box when “other” is selected.

Question 24	What species do you **usually catch** with the longline? Anything else?	☐ Gummy shark ☐ School shark ☐ Draughtboard shark (Swellshark, Checkerboard, Nutcracker, Sleepy Joe, Wobbegong) ☐ Port Jackson shark ☐ Broad-nosed shark (Tiger shark, 7-gill shark) ☐ Other sharks ☐ Rays / Skates ☐ Elephant fish (Elephant shark) ☐ Flathead (Sandies, Tiger, King flathead) ☐ Flounder (Greenback, Sole) ☐ Gurnard (Common, Coral, Ocean, Rough) ☐ Cod ☐ Striped trumpeter (Stripies) ☐ Bastard trumpeter (Not often taken by hook) ☐ Jackass morwong (Perch) ☐ Banded morwong (Carp - not often taken on hooks) ☐ Blue moki (Silver morwong) ☐ Snapper ☐ Blue warehou (Snotties or Snotty trevally) ☐ Silver trevally ☐ Yellowtail kingfish (Kingie) ☐ Blue eye trevalla (Blue eye) ☐ Hapuka / Hapuku ☐ Bass groper ☐ Gemfish ☐ Blue grenadier (Whiptail, Rat tail) ☐ Ling ☐ Tuna (Bluefin, Albacore, skipjack, yellowfin) ☐ Swordfish (Broadbill, Swordie) ☐ Mako shark (Marco) ☐ Barracouta (couda, couta) ☐ Other

Question 25

Q25 seeks to determine which of the species listed in Q24 are unwanted bycatch species. It is important to reassure the respondent that the survey does not require definition of whether bycatch was returned to the water dead or alive. Tick appropriate boxes next to the common names of species used in the fishery. Multiple species can be selected, and species not on the list can be added in the text box when “other” is selected.

Question 25	What about species you catch but you **return to the water**? Anything else?	☐ Gummy shark ☐ School shark ☐ Draughtboard shark (Swellshark, Checkerboard, Nutcracker, Sleepy Joe, Wobbegong) ☐ Port Jackson shark ☐ Broad-nosed shark (Tiger shark, 7-gill shark) ☐ Other sharks ☐ Rays / Skates ☐ Elephant fish (Elephant shark) ☐ Flathead (Sandies, Tiger, King flathead) ☐ Flounder (Greenback, Sole) ☐ Gurnard (Common, Coral, Ocean, Rough) ☐ Cod ☐ Striped trumpeter (Stripies) ☐ Bastard trumpeter (Not often taken by hook) ☐ Jackass morwong (Perch) ☐ Banded morwong (Carp - not often taken on hooks) ☐ Blue moki (Silver morwong) ☐ Snapper ☐ Blue warehou (Snotties or Snotty trevally) ☐ Silver trevally ☐ Yellowtail kingfish (Kingie) ☐ Blue eye trevalla (Blue eye) ☐ Hapuka / Hapuku ☐ Bass groper ☐ Gemfish ☐ Blue grenadier (Whiptail, Rat tail) ☐ Ling ☐ Tuna (Bluefin, Albacore, skipjack, yellowfin) ☐ Swordfish (Broadbill, Swordie) ☐ Mako shark (Marco) ☐ Barracouta (couda, couta) ☐ Other

Question 26

This question seeks information on the general regions in Tasmania where recreational longline fishing takes place. Multiple regions can be selected as fishers may move around with the seasons. General fishing regions were used to reduce the concern by fishers that they are not required to give away their favourite fishing locations. However, some fishers will be specific and name a particular location. Record these locations in the "near" box and ask what town the location is closest to. This will help assign the location to the most appropriate regions at a later date.

Question 26	What are the general regions in Tasmania where you have gone longline fishing in the past 12 months? Any others?	☐ North coast ☐ North East coast ☐ East coast ☐ South East coast ☐ South coast ☐ West coast ☐ King Island ☐ Flinders Island ☐ Cape Barren Island ☐ Clarke Island ☐ Specified locations. Where is that near?

Question 27

This question determines what depths the longline fishers prefer to set their gear. Multiple depth categories can be selected as fishers may target particular species in different water depths. If in

addition to selecting species from the dropline fisher target species in the previous questions and they answer a depth of around 100+ m, it can be assumed they are a dropline fisher. Continue through the survey but make note when you reach the interview comments box. Only read out relevant information at Q47 and do not imply that coupons will be sent to potentially gain additional rewards. Ensure no quotations marks (“) are used in the text.

Question 27	In what water depths do you typically set the longline?	☐ 0-10 m (0-5 fathoms) ☐ 11-30 m (5-15 fa) ☐ 31-50 m (15-25 fa) ☐ 51-100 m (25-50 fa) ☐ 300 m (>150 fa) ☐ Opted out

Question 28

This question will gather general information on the general habitats where fishers prefer to set their longline. Tick appropriate boxes next to the habitat types. Multiple habitats can be selected, and habitats not on the list can be added in the text box when “Other” is selected.

Question 28	What kinds of habitats do you generally look for when setting the longline?	☐ Bare sand ☐ Gravel ☐ Reef ☐ Kelp forests ☐ Opted out ☐ Other

Question 29

It is desirable to know if there is a defined season and a peak of activity for the Tasmanian longline fishery, or whether fishing occurs year-round. This is important for determining when might be the most appropriate time to start and finish a survey. Select the appropriate month from the drop-down menu to define when the respondent starts and ceases fishing, and when peak fishing activity occurs.

Question 29	What months would you typically go longline fishing? And what is the peak month of your longline fishing activity?	**From:** ▾ **To:** ▾ **Peak activity:** ▾

Question 30

Determining how long a longline is soaked for is important for standardising and/or estimating fishing effort. This questions requests fishers to estimate how long they leave their baited longlines before retrieval. Enter a number in the box, or “NA” if the respondent opts not to answer the question.

Question 30	When you set your longline, how many hours do you usually leave it for before hauling it up?	hours Enter NA for no response

Question 31

This question also seeks to collect information that can be used to estimate fishing effort by asking how many times a fisher would typically set a longline in a single day of fishing. Enter a number in the box, or "NA" if the respondent opts not to answer the question.

Question 31	How many longline sets would you do in a typical day of fishing?	sets Enter NA for no response

Question 32

This question seeks to collect information that can be used to estimate annual fishing effort by asking how many days the respondent has fished in the past year. Enter a number in the box, or "NA" if the respondent opts not to answer the question.

Question 32	In the past 12 months, how many days did you fish with a longline, whether you caught anything or not?	days Enter NA for no response

Question 33

The next few questions relate to the respondent's expenditure on fishing-related goods and services for trips undertaken in the past 12 months. It needs to be reiterated to the respondent that it is the daily expenditure for them to participate in longline fishing only. Confusion can often arise when a group fishes together and split the costs among them. Furthermore, some trips may be primarily for targeting species with other gear types (e.g. offshore gamefishing), but they will set a longline on the way out or in.

Question 33	On those trips when you fished with a longline, I want you to think about how much money would you spend that was directly related to longline fishing.	

Question 34

This question seeks to obtain an estimate of the average daily expenditure on boat fuel by the respondent in the previous 12 months. Remember to split fuel costs by the average number of people that the respondent usually fishes with on an average day of fishing. Attempt to determine what percentage of costs such as fuel can be attributed to longlining only if other fishing activities are also undertaken during each trip.

Question 34	Let's start with your average fuel cost for the boat on each day of longlining	$ Enter NA for no response

Question 35

For an average day of longline fishing, determine how much the respondent spent on bait (including berley). Remember to split bait costs by the average number of people that the respondent usually fishes with on an average day of fishing.

Question 35	What about bait?	$ Enter NA for no response

Question 36

For an average day of longline fishing, determine how much the respondent spent on fishing tackle. These are items generally termed "terminal tackle" such as traces, hooks, sinkers, etc. Do not include major items such as rod, reels, winches, or mail lines which are not replaced frequently.

Question 36	What about tackle? These are items such as traces, hooks, sinker, swivels, etc, but not rods, reels, winches, or mainlines.	$ Enter NA for no response

Question 37

Determine whether there are any other expenses incurred by the participant on an average day of longline fishing. Sum all 'other' expenses and record the total cost. If applicable, remember to split 'other' costs by the average number of people that the respondent usually fishes with on an average day of fishing.

Question 37	Any other expenses?	$ Enter NA for no response

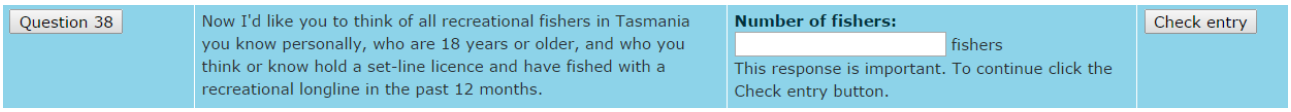
Important RDS-specific questions

The following questions are of critical importance since RDS analyses cannot be performed without an estimate of the personal degree each respondent. This allows the researcher to ajust for differential recruitment bias that is introduced by some groups (e.g. fishing club members) having larger degrees than another group (e.g. non-club members). If left unadjusted, the population estimates from RDS analyses will be incorrect since individuals from the group with a larger degree has a higher probability of being recruited.

To make sure that these questions are answered there is an extra step in order to move on with the survey. After the answer is filled in, you must select the Check entry button under the *Further Information* tab.

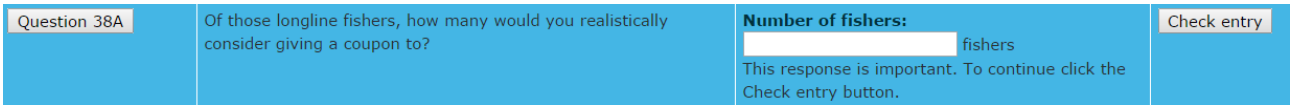
Question 38

This question seeks information on the total number of eligible subjects the respondent knows personally. This is the "extended degree". Because of the importance of this question to the survey before continuing to Q38A the Check entry button must be clicked.



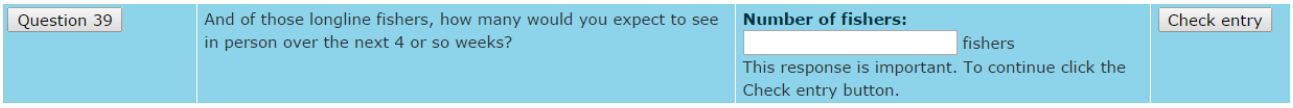
Question 38A

This question seeks information on the total number of eligible subjects the respondent knows personally, and whom they would consider to pass a coupon to. This is the "effective degree" and is important to determine the selection probability. This number needs to be equal to, or smaller than, the degree estimate provided in Q38. Again this response is important so the Check entry button must be clicked before continuing.



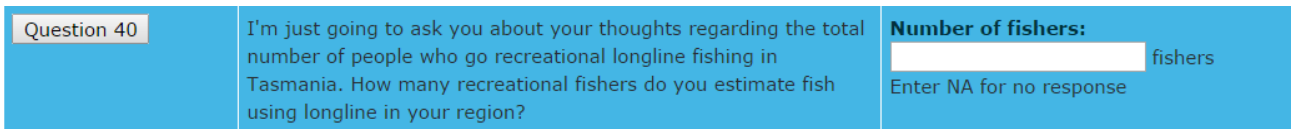
Question 39

This question seeks information on the number of eligible subjects from the "effective degree" who the respondent is likely to see in the next month. This number should be equal to, or smaller than, the degree estimate given in Q38A. Make sure the Check entry button is clicked to move on with the survey.



Question 40

Estimating the size of hard-to-reach populations is often difficult, since a complete list frame is generally not available. It has been suggested that people within 'inside knowledge' of hidden population can produce reasonably accurate estimates of population size. Wisdom of the Crowds is a concept that relies on the collective knowledge of members of the hidden population to estimate population size. This question seeks to obtain an estimate of the number of longline fishers in the respondent's primary fishing region (e.g. north coast as stated in Q26).

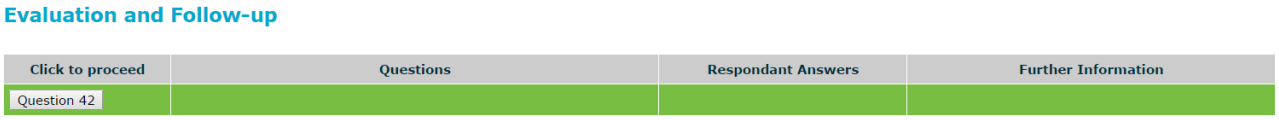


Question 41

Question 41 is similar to Q40 but requests respondents to estimate the number of longline fishers in all of Tasmania rather than each respondent's primary fishing region.

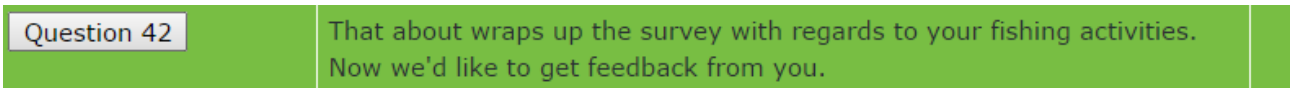
Respondent contact information and feedback

The final section of the survey has comments sections for the respondent to make suggestions about the fishery and about the survey itself, such as suggesting questions they think the survey should have asked. It is also important to remember to collect the postal details of the respondent to successfully post their reward kit. Check spelling of names, street names and suburbs as well as post codes.



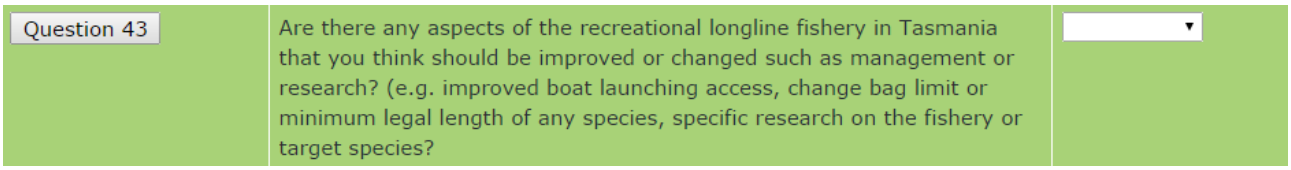
Question 42

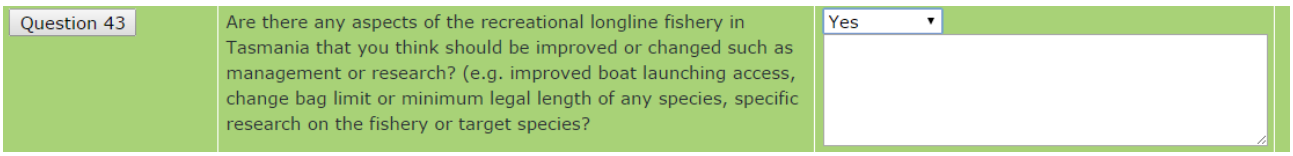
Read the dialogue that is under the *Questions* tab.



Question 43

The respondent does not need to answer this question, but if they do answer yes type their response in the white box to the right of the question. If the answer is quite long try to summarise the important information. Ensure no quotations marks ("") are used in the text box.





Question 44

This question, if answered "yes", brings up Question 45, if "no" go straight to Question 47.

Question 44	One final question. After the survey is complete we would value your feedback on your experience with this new style of survey. Is it ok if we contact you in around 6-8 weeks?	

Question 44	One final question. After the survey is complete we would value your feedback on your experience with this new style of survey. Is it ok if we contact you in around 6-8 weeks?	Yes
Question 45		
Question 46		
Question 47		

Question 45

Question 45 gathers information about the respondent's contact number to allow survey staff to complete a follow up survey (if permission is granted) and to ensure rewards are received.

Question 45	What would the best number be to call you on?	**Primary contact number:** **Secondary contact number:**

Question 46

Allows the respondent to advise the research team of a suitable time to complete the follow up survey.

Question 46	And what would be the best times to call you?	

Question 47

Read out the dialogue under the *Questions* tab to the respondent. This information is important for the respondent to understand, but it is also reiterated in the reward pack. If it is revealed during the survey that an ineligible respondent proceeded through the eligibility screening questions, only read the first and last sentence of the paragraph.

Question 47	Ok, thanks so much for your time in completing the survey. From here we will send you a $20 reward card. In the same package, we will include three coupons. This can earn you an additional $30 if you give the coupons to other recreational longline fishers in Tasmania. You can physically give each person a coupon, or simply call, text or email them the coupon ID code along with our contact freecall 1800 number. You must only give one coupon or code to a single person who holds a set-line licence, has not already participated in the survey, and is not a stranger to you. You must know the person. You will receive $10 for each eligible person who completes the entire survey. If they do not qualify or complete the survey we cannot issue you with a reward. Detailed instructions regarding the coupons will be included with your reward package. Should you successfully recruit other longline fishers to the study, your rewards will be sent out at a later date. If you have any questions, please call us on the 1800 number Monday to Friday and we can assist you.

Question 48

This needs to be filled out in order to send the respondent their reward and coupon kit. If they do not disclose this information then it will not be possible to send out the reward.

Question 48	We will send your reward, coupons and information package out to you within the next week, so can I get the best postal address to send these to? As well as your name?	▾

Question 48	We will send your reward, coupons and information package out to you within the next week, so can I get the best postal address to send these to? As well as your name?	Yes ▾ **First name:** **Surname:** **Address 1:** **Address 2:** **Town:** **Postcode:**

Question 49

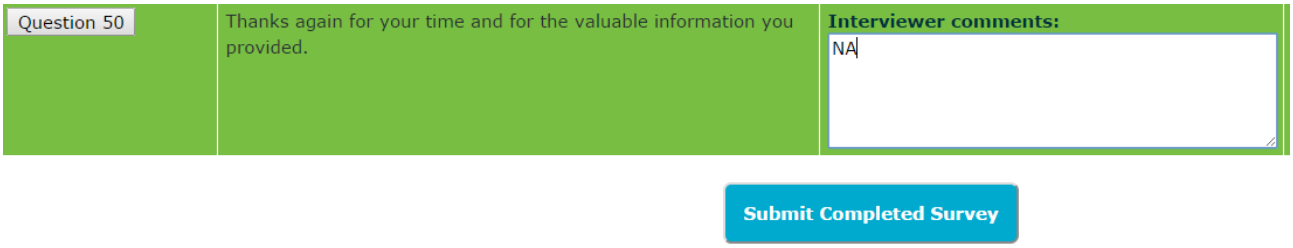
This question only appears if the participant answered ‘no’ to Q48. If they answered no this means that no coupon or reward will be sent to this respondent.

Question 50	Thanks again for your time and for the valuable information you provided.	**Interviewer comments:**

Finalising the Survey

Question 50

Thank the respondent for their input into the survey by reading out the dialogue provided.



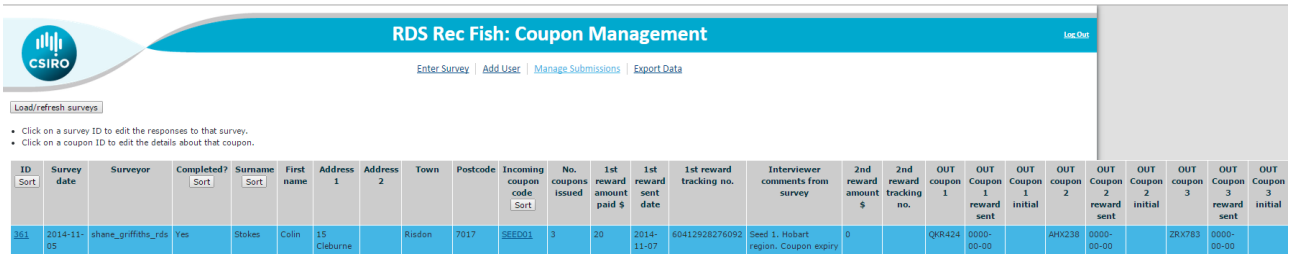
If there is any outstanding information in regards to the survey that does not fit into any question make a note in interviewer comments. This section is also important for people who have a survey code and are ineligible to complete the survey, or participants who progressed through the screening questions but were later identified not be longline fishers. This lets the researcher know of any anomalies. In this section it can also be noted if someone needs to be sent a reward despite not being eligible to complete the survey, taking note of their name and address. Ensure no quotations marks (“”) are used in the text.

Once the “Submit Completed Survey” button is clicked the webpage will direct the user back to the login page to start again. It is advisable to refresh the page to ensure all data are clear from the cache.

The survey is now complete.

Coupon Manager

In order to manage the coupons in the survey a coupon management system was established. The coupon manager can be accessed by opening http://cmar-webhost.it.csiro.au/rdsrecfish/survey.php in a new window or tab. Instead of selecting "Enter Survey" to complete a new survey, select "Manage Submissions" near the top of the screen. A screen similar to the one below will appear and allowing coupon details to be managed and survey information to be added if required.



After each survey is complete and the reward kit is made up for each person. This process also requires each entry to be updated with reward kit information and registered post information. Most importantly, the coupon manager is to be used to record the reward amounts, the date rewards were issued, and the serial numbers of the reward cards and registered post serial numbers. This allows all information to be traced in the event a card is lost or a respondent enquires about their reward status.

Appendix 4. Letter to RDS seed respondents

Tasmanian Recreational Set-line Fishery Survey

6 November 2014

Background and need for the research

The CSIRO is Australia's premiere research agency, which tackles national-level science issues. Its role is to provide high quality impartial research that can be used by all Australians. In recent years, the recreational fishery has diversified to the extent where important specialised recreational fisheries are too expensive to survey using traditional survey techniques (e.g. boat ramp surveys). Given that many specialised recreational fisheries across Australia have a similar data needs and difficulties in gathering data, the CSIRO has received funding to trial a new survey method that is both low cost and highly effective for surveying 'hard-to-reach' populations of people. The method is called "Respondent-Driven Sampling" (RDS) and has been used for many years in the health sciences to monitor the prevalence of HIV and other rare diseases within in the general population. The method provides a reward to a respondent to participate in a short survey, and a second reward for referring other eligible fishers to the study.

Objectives of the research

The CSIRO aims to provide reliable baseline information on many specialised recreational fisheries around Australia (e.g. frequency of fishing, target species, and expenditure). Future research can then build upon such baseline data to help meet the data needs of the recreational fishery. The longline component of the Tasmanian recreational set-line fishery has been chosen to be the next specialised fishery for study, and the first fishery in the world to ever be sampled using the RDS method.

There are two main reasons to trial RDS in the longline fishery. First, it is a little understood specialised, unique and spatially discrete fishery comprised of reasonably small number of participants. Second, longline fishers are required to hold a set-line licence, enabling us to assess how well the RDS method works by comparing our sample of fishers with the full list of licenced longline fishers. It is very important for the CSIRO to reiterate that **this research project has not arisen from management concerns** over catch or effort levels in the fishery, and **the data from the survey are not being collected for the purposes of influencing management or policy development**. The CSIRO is an independent scientific research provider, so this is purely a scientific research project that aims to collect impartial high quality data that can be used by all fishery stakeholders.

Your role in the research

Your role as a 'seed' to begin the survey chain is very important, since you can initially dictate the direction and speed that the survey will progress. Our ultimate aim is to gain a representative picture of the recreational longline fishery, by sampling all types of longline fishers across the entire state of Tasmania. To optimise the coverage of survey coupons across Tasmania, we have selected a single 'seed' in 5 regions around Tasmania (Strahan, Burnie, Davenport, St Helens, and Hobart) and request that each seed gives their 3 referral coupons (or coupon codes) to other eligible longline fishers within their region. This will give the survey a chance to recruit fishers from within each region before the next 'wave' of recruits distributes their coupons more widely. Enclosed is a wallet containing your initial $20 reward, 3 x coupons, and detailed instructions on how to distribute your coupons. If you have any questions regarding the project, please do not hesitate to contact me on (07) 3822 5927 or 0408 977 417.

Kind regards,

Appendix 5. Tasmanian recreational rock lobster fishery questionnaire

	Question	
	"Hello, I'm just returning your call to the Tasmanian Recreational Rock Lobster Fishing Survey. My name is Tim/Lincoln/Curt/Carlie and I'll be assisting you today. Is now a good time to complete the 15 min interview?"	
1	**Can I please start with your first and last name? Can you spell it please?**	_____
	Great, I'm now going to ask you a few simple questions to determine your eligibility for the study.	
2	**Can I confirm your coupon code?**	_____
3	**And was that code from a Yellow paper coupon, or were you just sent a code by someone?**	1) Seed code issued 2) Paper 3) Give code
4	**Did you receive the coupon or code in person, in the post, by phone, txt, email, social media, or found the code or coupon?**	1) Paper coupon in person 2) Paper coupon by mail 3) Code by phone/txt 4) Code by email 5) Code by social media 6) Found paper coupon 7) Found code online
5	**To validate the code, can you please tell me the first name of the person who gave you the coupon? CONFIRM COUPON CARRIER**	1) Correct name 2) Incorrect name

3) No name provided

6 **How would you best describe your relationship with the person who gave you the coupon?**

1) Work colleague

2) A close friend

3) Acquaintance

4) Couple/Partner

5) Relative

6) Stranger

7) Other

7 **Have you previously completed this survey?**

Yes / No

9 **And what is your current post code?**

_____

10 **Do you currently hold a Tasmanian recreational rock lobster licence for the 2016/17 season? (That is, from 1 Nov 2016 to 31 Oct 2017)**

Yes / No

11 **Did you hold a Tasmanian recreational rock lobster licence for the 2015/16 season? (That is, from 1 Nov 2015 to 31 Oct 2016)**

Yes / No

12 **In the previous 12 months have you fished, or intend to fish in the next 12 months, for rock lobster in Tasmania?**

Yes / No

"Ok, I've been able to determine that you are eligible for the study. This study is seeking to understand the economic contribution made by the recreational rock lobster fishers in Tasmania. The survey will take approximately 15 minutes and I will ask you some general questions about your lobster fishing activities and then talk specifically about your expenditure on lobster fishing. On completion of the survey you will receive a $20 reward in the form of an EFTPOS cash card, just like an ATM card, which can be used to buy anything where EPFTOS cards can be used. You can also receive up to an additional $30 by referring other eligible recreational rock lobster fishers to this study, but I'll discuss that later."

CONSENT FORM: "First, we require your consent to proceed with this survey. This information will not be used in a way where you can be identified. The data will only ever be reported in aggregated form and ultimately be held by the CSIRO. You are within your right to refuse to answer any question or to stop the interview at any time. However, we cannot provide the $20 reward for an incomplete interview. This survey has been approved by the CSIRO Human Ethics Committee, but if for any reason you are not satisfied with the content or delivery of the survey you can lodge a complaint via the committee (Cathy.Pitkin@csiro.au or 07 3833 5693).

---

13 **Do you understand these terms and give your consent to proceed?**

Yes / No

Great, I'm now going to ask you some general questions about yourself, and your rock lobster fishing activities, before asking some specific questions about your expenditure on rock lobster fishing

---

14 **Gender by observation**

Male / Female / Indeterminate

15 **What would you say was your primary motivation for participating in this survey?**

1) Favour to a friend

2) Reward

3) Help research

4) Curious about the project

5) I was forced

6) Other

16 **Have you been a member of a fishing or dive club in the past 12 months?**

Yes / No

16A **Which clubs are you a member?**

_____

17 **How many years have you fished for rock lobster in Tasmania (using any method)?**

_____

18 **In the past 12 months, how many days did you go lobster fishing, whether you caught anything or not? (If none go to Q21)**

_____

19 **How many lobsters did you personally catch, excluding any that you released?**

_____

20 **What is the primary method you use when targeting rock lobster? (Pot, dive, hoop) If Dive-> are you primarily a free diver/ SCUBA diver? (Mark as comment)**

Pot / Dive / Ring

20A **Did you use more than one method of fishing for the past 12 months (estimate your percentage use of each method)?**

Pot: _____ %

Dive: ____ %

Ring: ____ %

21 **ONLY ASK IF DIDN'T GO FISHING: So what was the main reason you haven't gone fishing for lobsters during the past 12 months?**

_____

Now, let's talk about the amount you spend per trip on lobster fishing. (For potters setting and retreiving pots can be considered one trip) Thinking about the last time you went fishing for lobsters, if this was an average trip, how much would you personally spend on the following?

---

22 **Comsumables such as ice / bait or if a diver air-fills**

$_____

23 **Boat charter / boat hire?**

$_____

24 **Fuel costs for motor vehicle travel to the fishing site?**

$_____ (Return trip)

25 **Distanced traveled buy car**

_____ Km (Return trip)

26 **Boat running costs (fuel/oil)?**

$_____

27 **Average trip length in days or decimals of days**

_____ days

28 **Food and drink**

$_____

29 **Any other (trip) expenditure to go lobster fishing?**

$_____

Now, let's talk more generally about what YOU spend per year on all forms of fishing. Over the PAST 12 MONTHS, what is the typical amount YOU would personally spend on the following?

30 **Boat mooring/storage fees?**

$_____

31 **Boat/trailer insurance/rego?**

$_____

32 **Boat/trailer purchases or capital items (e.g. motors, electronics)?**

$_____

33 **Boat/trailer maintenance (incl. servicing) e.g. PFD, gear servicing?**

$_____

34 **Camping gear associated with fishing?**

$_____

35 **Accommodation associated with fishing**

$_____

36 **Fishing books/ magazines?**

$_____

37 **Specialised clothing (e.g. wetsuits, booties, gloves, wet weather gear)?**

$_____

38 **Licences/ fees/memberships (e.g. licence, fishing club, competitions)?**

$_____

39 **Annual tackle expenditure. specific fishing or dive gear purchases for that trip (General: reels, rods, lures, tackles) (Potter: pots, floats, / Divers: Regs, BCs, Catch Bag, Weight Belt)?**

$_____

40 **For your general fishing expenditure what proportion would be spent on Rock Lobster Fishing compared to all of the fishing that you do? (e.g. If you just go rock lobster fishing this will be 100%)**

_____
%

Great, now I'd like to ask a three quick questions about people you know who fish for lobsters.

41 **First of all, how many licenced lobster fishers do you know in Tassie, who are 18 years or older, and have fished for lobster in the past 12 months. For this study, knowing someone means that you know the person well enough to comfortable hold a conversation with them.**

_____

42 **How many of these fishers would you see in the near future - say over a month – to give a coupon to?**

_____

43 **Turning this around How many of them do you think would have given you a coupon in the next month if they had one?**

_____

44 **This concluded the survey. We will send your reward, coupons and information package out to you in the next few days, so can I get the best STREET ADDRESS or PO BOX to send these to?**

_____

45 **And what SUBURB is that?**

_____

46 **And what is the postcode?**

_____

Thanks again for your time and for the valuable information you provided. At this point I will request that you destroy your yellow coupon as it is now void. Along with your rewards you will be issued with 3 new survey coupons that we hope you will pass on to other lobster fishers whom you know personally. These people have to be at least 18 years of age, they cannot be a stranger to you, and they must NOT have participated in the survey previously. You will receive an additional $10 rewards card for each of your eligible peers who go on to complete the survey as you have done. Unfortunatley, if your selected peers are ineligible or do not complete the survey we cannot issue you with a reward for that person. Details of this aspect of the survey will be provided in the documentation that we will be sending you.

Thanks again for participating in this survey. The full results of the survey will be available publicly by the end of the year. (TERMINATE CALL)

FOR INTERNAL USE

Number of coupons issued to respondent

Coupon Code 1 (e.g. XYM663)

Coupon Code 2 (e.g. ZAD334)

Coupon Code 3 (e.g. ZAD334)

Enter the expiry date for the coupons

Enter the interviewer name

Interview date Comment and phone number

Appendix 6. Tasmanian recreational rock lobster fishery wash up survey

	Question
	Hello, could I speak to__please? This is__from CSIRO *Hi __, we are just following up on the recreational rock lobster survey you participated in recently where we issued you with a reward. Is now a good time for a 5 minute chat to answer a few questions related to the study?*
1	**First, we require your consent that you are granting us permission to proceed with this survey. This information will not be used in a way where you can be identified. The data will only ever be reported in aggregated form and ultimately be held by the CSIRO. You are within your right to refuse to answer any question or to stop the interview at any time. Do you understand these terms and give your consent to proceed?** yes no
	First of all we'd like to thank you for your participation in the recreational rock lobster fishery survey. As you are probably aware, we used a different survey approach for this study, and we would like to evaluate the seeding process. So I'd like to ask you some questions about your experience so far.
2	**As you may remember, when we first conducted the survey with you in January, we issued you with 3 yellow coupons along with your reward package. We would like to first ask have you pass along those coupons to your peers?** yes no (go to Q6)
3	**Approximately when did you pass the coupons out?** Comment
4	**On a scale of 1 to 5 (1 being very challenging and 5 being very easy), Do you find it difficult to find other rock lobster fisher to participate the survey?** 1 2 3 4 5
5	**What would you say is the most challenging factor when handing out the coupons?** Comment
6	**May I ask why you haven't pass on your coupons to your peers?** Comment

7 Do you think you will pass on the coupons to your peer in the near future? (next couple of weeks)

yes no

This concludes this follow up survey. Thanks again for your participation in the survey and for providing feedback on the survey method.

Appendix 7. Census data for Ecosciences Precinct staff

Census data for the 827 resident staff at the Ecosciences Precinct showing agency, building level where workstation is located, and gender. Staff names have been removed and replaced with an arbitrary staff ID.

Staff ID	Agency	Level	Gender		Staff ID	Agency	Level	Gender
1	Uni SC	3	Female		51	CSIRO	G	Male
2	Griffith Uni	2	Male		52	CSIRO	G	Female
3	UQ	2	Female		53	CSIRO	G	Female
4	Griffith Uni	3	Male		54	CSIRO	G	Female
5	Griffith Uni	2	Female		55	CSIRO	G	Female
6	Griffith Uni	2	Male		56	CSIRO	G	Male
7	Griffith Uni	2	Male		57	CSIRO	G	Male
8	Griffith Uni	2	Female		58	CSIRO	G	Female
9	UQ	2	Female		59	CSIRO	G	Female
10	UQ	2	Female		60	CSIRO	G	Male
11	UQ	2	Male		61	CSIRO	G	Female
12	UQ	2	Male		62	CSIRO	G	Male
13	UQ	2	Female		63	CSIRO	G	Male
14	UQ	2	Male		64	CSIRO	G	Female
15	CSIRO	G	Female		65	CSIRO	G	Male
16	CSIRO	G	Female		66	CSIRO	G	Female
17	CSIRO	G	Male		67	CSIRO	G	Male
18	CSIRO	G	Male		68	CSIRO	G	Male
19	CSIRO	G	Female		69	CSIRO	G	Male
20	CSIRO	G	Female		70	CSIRO	G	Female
21	CSIRO	G	Male		71	CSIRO	G	Male
22	CSIRO	G	Female		72	CSIRO	G	Male
23	CSIRO	G	Male		73	CSIRO	G	Male
24	CSIRO	G	Male		74	CSIRO	G	Female
25	CSIRO	G	Female		75	CSIRO	G	Female
26	CSIRO	G	Female		76	CSIRO	G	Female
27	CSIRO	G	Male		77	CSIRO	G	Male
28	CSIRO	G	Female		78	CSIRO	G	Female
29	CSIRO	G	Female		79	CSIRO	G	Male
30	CSIRO	G	Female		80	CSIRO	G	Female
31	CSIRO	G	Female		81	CSIRO	G	Female
32	CSIRO	G	Female		82	CSIRO	G	Male
33	CSIRO	G	Female		83	CSIRO	G	Female
34	CSIRO	G	Female		84	CSIRO	G	Female
35	CSIRO	G	Female		85	CSIRO	G	Male
36	CSIRO	G	Female		86	CSIRO	G	Female
37	CSIRO	G	Female		87	CSIRO	G	Female
38	CSIRO	G	Female		88	CSIRO	G	Female
39	CSIRO	G	Female		89	CSIRO	G	Female
40	CSIRO	G	Male		90	CSIRO	1	Female
41	CSIRO	G	Female		91	CSIRO	1	Male
42	CSIRO	G	Female		92	CSIRO	1	Female
43	CSIRO	G	Female		93	CSIRO	1	Male
44	CSIRO	G	Male		94	CSIRO	1	Female
45	CSIRO	G	Female		95	CSIRO	1	Female
46	CSIRO	G	Male		96	CSIRO	1	Male
47	CSIRO	G	Male		97	CSIRO	1	Male
48	CSIRO	G	Male		98	CSIRO	1	Male
49	CSIRO	G	Male		99	CSIRO	1	Male
50	CSIRO	G	Female		100	CSIRO	1	Male

Staff ID	Agency	Level	Gender	Staff ID	Agency	Level	Gender
101	CSIRO	1	Male	151	CSIRO	1	Male
102	CSIRO	1	Female	152	CSIRO	1	Male
103	CSIRO	1	Female	153	CSIRO	1	Male
104	CSIRO	1	Female	154	CSIRO	1	Male
105	CSIRO	1	Female	155	CSIRO	1	Male
106	CSIRO	1	Female	156	CSIRO	1	Male
107	CSIRO	1	Male	157	CSIRO	1	Male
108	CSIRO	1	Female	158	CSIRO	1	Male
109	CSIRO	1	Male	159	CSIRO	1	Male
110	CSIRO	1	Male	160	CSIRO	1	Female
111	CSIRO	1	Female	161	CSIRO	1	Male
112	CSIRO	1	Female	162	CSIRO	1	Male
113	CSIRO	1	Male	163	CSIRO	1	Male
114	CSIRO	1	Female	164	CSIRO	1	Male
115	CSIRO	1	Male	165	CSIRO	1	Female
116	CSIRO	1	Male	166	CSIRO	1	Male
117	CSIRO	1	Female	167	CSIRO	1	Male
118	CSIRO	1	Male	168	CSIRO	1	Male
119	CSIRO	1	Male	169	CSIRO	1	Male
120	CSIRO	1	Male	170	CSIRO	1	Male
121	CSIRO	1	Male	171	CSIRO	1	Male
122	CSIRO	1	Male	172	CSIRO	1	Female
123	CSIRO	1	Female	173	CSIRO	1	Female
124	CSIRO	1	Male	174	CSIRO	1	Male
125	CSIRO	1	Female	175	CSIRO	1	Female
126	CSIRO	1	Female	176	CSIRO	1	Male
127	CSIRO	1	Female	177	CSIRO	1	Female
128	CSIRO	1	Male	178	CSIRO	1	Male
129	CSIRO	1	Female	179	CSIRO	1	Male
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132	CSIRO	1	Male	182	CSIRO	1	Male
133	CSIRO	1	Male	183	CSIRO	1	Female
134	CSIRO	1	Male	184	CSIRO	1	Male
135	CSIRO	1	Male	185	CSIRO	1	Female
136	CSIRO	1	Male	186	CSIRO	1	Male
137	CSIRO	1	Male	187	CSIRO	1	Female
138	CSIRO	1	Male	188	CSIRO	1	Female
139	CSIRO	1	Male	189	CSIRO	1	Male
140	CSIRO	1	Female	190	CSIRO	1	Male
141	CSIRO	1	Female	191	CSIRO	1	Male
142	CSIRO	1	Female	192	CSIRO	1	Female
143	CSIRO	1	Female	193	CSIRO	1	Male
144	CSIRO	1	Male	194	CSIRO	1	Male
145	CSIRO	1	Male	195	CSIRO	1	Male
146	CSIRO	1	Male	196	CSIRO	1	Male
147	CSIRO	1	Male	197	CSIRO	1	Female
148	CSIRO	1	Male	198	CSIRO	1	Female
149	CSIRO	1	Male	199	CSIRO	1	Male
150	CSIRO	1	Male	200	CSIRO	1	Male

Staff ID	Agency	Level	Gender		Staff ID	Agency	Level	Gender
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202	CSIRO	1	Female		252	CSIRO	1	Male
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204	CSIRO	1	Male		254	CSIRO	1	Male
205	CSIRO	1	Male		255	CSIRO	1	Male
206	CSIRO	1	Female		256	CSIRO	3	Female
207	CSIRO	1	Male		257	CSIRO	3	Female
208	CSIRO	1	Female		258	CSIRO	3	Male
209	CSIRO	1	Female		259	CSIRO	3	Male
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211	CSIRO	1	Female		261	CSIRO	3	Female
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213	CSIRO	1	Female		263	CSIRO	3	Male
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224	CSIRO	1	Female		274	CSIRO	3	Male
225	CSIRO	1	Female		275	CSIRO	3	Male
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229	CSIRO	1	Female		279	CSIRO	3	Female
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237	CSIRO	1	Male		287	CSIRO	4	Female
238	CSIRO	1	Male		288	CSIRO	4	Male
239	CSIRO	1	Female		289	CSIRO	4	Female
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241	CSIRO	1	Female		291	CSIRO	4	Male
242	CSIRO	1	Male		292	CSIRO	4	Male
243	CSIRO	1	Female		293	CSIRO	4	Male
244	CSIRO	1	Male		294	CSIRO	4	Male
245	CSIRO	1	Male		295	CSIRO	B1	Male
246	CSIRO	1	Male		296	CSIRO	B1	Male
247	CSIRO	1	Female		297	DSITIA	G	Male
248	CSIRO	1	Male		298	DSITIA	G	Male
249	CSIRO	1	Female		299	DSITIA	G	Male
250	CSIRO	1	Male		300	DSITIA	G	Male

Staff ID	Agency	Level	Gender		Staff ID	Agency	Level	Gender
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306	DSITIA	G	Male		356	DSITIA	1	Male
307	DSITIA	G	Male		357	DSITIA	1	Male
308	DSITIA	G	Female		358	DSITIA	1	Male
309	DSITIA	G	Male		359	DSITIA	1	Female
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312	DSITIA	G	Male		362	DSITIA	1	Male
313	DSITIA	G	Female		363	DSITIA	1	Male
314	DSITIA	G	Male		364	DSITIA	1	Female
315	DSITIA	1	Male		365	DSITIA	1	Female
316	DSITIA	1	Male		366	DSITIA	1	Female
317	DSITIA	1	Female		367	DSITIA	1	Female
318	DSITIA	1	Male		368	DSITIA	3	Female
319	DSITIA	1	Male		369	DSITIA	3	Male
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323	DSITIA	1	Female		373	DSITIA	2	Male
324	DSITIA	1	Male		374	DSITIA	2	Female
325	DSITIA	1	Male		375	DSITIA	2	Female
326	DSITIA	1	Female		376	DSITIA	2	Male
327	DSITIA	1	Female		377	DSITIA	2	Male
328	DSITIA	1	Male		378	DSITIA	2	Male
329	DSITIA	1	Male		379	DSITIA	2	Male
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332	DSITIA	1	Male		382	DSITIA	2	Male
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343	DSITIA	1	Female		393	DSITIA	2	Female
344	DSITIA	1	Female		394	DSITIA	2	Female
345	DSITIA	1	Male		395	DSITIA	2	Male
346	DSITIA	1	Male		396	DSITIA	2	Male
347	DSITIA	1	Male		397	DSITIA	2	Female
348	DSITIA	1	Male		398	DSITIA	2	Male
349	DSITIA	1	Male		399	DSITIA	2	Male
350	DSITIA	1	Female		400	DSITIA	2	Male

Staff ID	Agency	Level	Gender		Staff ID	Agency	Level	Gender
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402	DSITIA	2	Female		452	DSITIA	3	Female
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404	DSITIA	2	Male		454	DSITIA	3	Female
405	DSITIA	2	Male		455	DSITIA	3	Male
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413	DSITIA	3	Male		463	DSITIA	3	Male
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415	DSITIA	3	Male		465	DSITIA	3	Male
416	DSITIA	3	Female		466	DSITIA	3	Female
417	DSITIA	3	Male		467	DSITIA	3	Female
418	DSITIA	2	Female		468	DSITIA	3	Male
419	DSITIA	3	Male		469	DSITIA	3	Male
420	DSITIA	3	Female		470	DSITIA	3	Male
421	DSITIA	3	Female		471	DSITIA	B1	Male
422	DSITIA	3	Female		472	DSITIA	G	Female
423	DSITIA	3	Female		473	DSITIA	G	Female
424	DSITIA	3	Male		474	DSITIA	G	Male
425	DSITIA	3	Female		475	DSITIA	G	Female
426	DSITIA	3	Female		476	DSITIA	G	Female
427	DSITIA	3	Male		477	DSITIA	G	Female
428	DSITIA	3	Female		478	DSITIA	G	Female
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431	DSITIA	2	Female		481	DSITIA	G	Female
432	DSITIA	2	Male		482	DSITIA	B1	Female
433	DSITIA	2	Female		483	DSITIA	G	Male
434	DSITIA	2	Male		484	DSITIA	G	Female
435	DSITIA	2	Male		485	DSITIA	G	Female
436	DSITIA	2	Male		486	DSITIA	B1	Male
437	DSITIA	2	Male		487	DSITIA	G	Female
438	DSITIA	2	Male		488	DSITIA	G	Female
439	DSITIA	2	Male		489	DSITIA	G	Female
440	DSITIA	2	Male		490	DSITIA	G	Female
441	DSITIA	2	Male		491	DSITIA	3	Female
442	DSITIA	2	Female		492	DSITIA	B1	Male
443	DSITIA	2	Female		493	DSITIA	G	Female
444	DSITIA	2	Female		494	DSITIA	G	Male
445	DSITIA	2	Male		495	DSITIA	G	Male
446	DSITIA	2	Male		496	DSITIA	G	Male
447	DSITIA	2	Male		497	DSITIA	G	Male
448	DSITIA	3	Male		498	DSITIA	G	Male
449	DSITIA	3	Female		499	DSITIA	G	Male
450	DSITIA	3	Female		500	DSITIA	G	Female

Staff ID	Agency	Level	Gender		Staff ID	Agency	Level	Gender
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502	DSITIA	G	Male		552	DSITIA	2	Female
503	DSITIA	G	Male		553	DSITIA	3	Female
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505	DSITIA	G	Female		555	DSITIA	G	Female
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512	DSITIA	G	Male		562	DSITIA	G	Female
513	DSITIA	G	Male		563	DSITIA	G	Male
514	DSITIA	G	Male		564	DSITIA	G	Male
515	DSITIA	G	Male		565	DSITIA	G	Female
516	DSITIA	G	Female		566	DSITIA	G	Male
517	DSITIA	G	Female		567	DSITIA	G	Male
518	DSITIA	G	Male		568	DSITIA	G	Male
519	DSITIA	G	Male		569	DSITIA	G	Male
520	DSITIA	G	Male		570	DSITIA	G	Male
521	DSITIA	G	Male		571	DSITIA	G	Male
522	DSITIA	3	Male		572	DSITIA	G	Male
523	DSITIA	3	Male		573	DSITIA	G	Male
524	DSITIA	3	Male		574	DSITIA	G	Female
525	DSITIA	3	Female		575	DSITIA	G	Male
526	DSITIA	3	Female		576	DSITIA	G	Female
527	DSITIA	3	Female		577	DSITIA	G	Female
528	DSITIA	3	Female		578	DSITIA	G	Male
529	DSITIA	3	Male		579	DSITIA	G	Male
530	DSITIA	3	Female		580	DSITIA	G	Male
531	DSITIA	3	Female		581	DSITIA	G	Male
532	DSITIA	3	Female		582	DSITIA	G	Male
533	DSITIA	3	Male		583	DSITIA	G	Male
534	DSITIA	3	Female		584	DSITIA	G	Female
535	DSITIA	3	Male		585	DSITIA	G	Female
536	DSITIA	3	Female		586	DSITIA	G	Female
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539	DSITIA	3	Female		589	DSITIA	G	Male
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541	DSITIA	3	Male		591	DSITIA	1	Male
542	DSITIA	3	Female		592	DSITIA	1	Male
543	DSITIA	3	Female		593	DSITIA	1	Female
544	DSITIA	3	Female		594	DSITIA	1	Male
545	DSITIA	3	Female		595	DSITIA	1	Female
546	DSITIA	3	Male		596	DSITIA	1	Male
547	DSITIA	3	Male		597	DSITIA	1	Female
548	DSITIA	3	Female		598	DSITIA	1	Female
549	DSITIA	3	Female		599	DSITIA	1	Male
550	DSITIA	2	Female		600	DSITIA	1	Male

Staff ID	Agency	Level	Gender		Staff ID	Agency	Level	Gender
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602	DSITIA	1	Female		652	DAFF	2	Male
603	DSITIA	1	Female		653	DAFF	3	Male
604	DSITIA	1	Male		654	DAFF	3	Male
605	DSITIA	1	Male		655	DAFF	3	Male
606	DSITIA	1	Female		656	DAFF	3	Male
607	DSITIA	1	Male		657	DAFF	B3	Male
608	DSITIA	1	Female		658	DAFF	2	Male
609	DAFF	1	Male		659	DAFF	2	Female
610	DAFF	1	Male		660	DAFF	2	Male
611	DAFF	2	Male		661	DAFF	2	Female
612	DAFF	2	Male		662	DAFF	3	Female
613	DAFF	1	Male		663	DAFF	2	Female
614	DAFF	2	Male		664	DAFF	2	Female
615	DAFF	2	Male		665	DAFF	3	Female
616	DAFF	3	Male		666	DAFF	3	Female
617	DAFF	3	Male		667	DAFF	G	Female
618	DAFF	3	Male		668	DAFF	2	Female
619	DAFF	3	Male		669	DAFF	2	Male
620	DAFF	2	Female		670	DAFF	2	Female
621	DAFF	4	Female		671	DAFF	2	Male
622	DAFF	3	Female		672	DAFF	3	Male
623	DAFF	3	Male		673	DAFF	1	Female
624	DAFF	2	Male		674	DAFF	2	Male
625	DAFF	2	Male		675	DAFF	3	Male
626	DAFF	G	Female		676	DAFF	B1	Male
627	DAFF	2	Male		677	DAFF	3	Male
628	DAFF	3	Male		678	DAFF	2	Male
629	DAFF	2	Male		679	DAFF	3	Female
630	DAFF	3	Male		680	DAFF	G	Female
631	DAFF	3	Male		681	DAFF	3	Female
632	DAFF	2	Female		682	DAFF	2	Male
633	DAFF	2	Male		683	DAFF	3	Female
634	DAFF	2	Female		684	DAFF	2	Female
635	DAFF	2	Female		685	DAFF	1	Male
636	DAFF	2	Female		686	DAFF	1	Male
637	DAFF	G	Female		687	DAFF	B3	Male
638	DAFF	2	Female		688	DAFF	2	Female
639	DAFF	2	Female		689	DAFF	2	Female
640	DAFF	2	Male		690	DAFF	2	Female
641	DAFF	2	Female		691	DAFF	3	Female
642	DAFF	3	Female		692	DAFF	3	Female
643	DAFF	2	Female		693	DAFF	1	Male
644	DAFF	G	Male		694	DAFF	3	Female
645	DAFF	1	Female		695	DAFF	2	Female
646	DAFF	G	Female		696	DAFF	3	Male
647	DAFF	1	Male		697	DAFF	2	Female
648	DAFF	2	Male		698	DAFF	G	Female
649	DAFF	2	Male		699	DAFF	3	Female
650	DAFF	G	Male		700	DAFF	3	Male

Staff ID	Agency	Level	Gender		Staff ID	Agency	Level	Gender
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702	DAFF	2	Male		752	DAFF	G	Female
703	DAFF	3	Male		753	DAFF	2	Male
704	DAFF	1	Male		754	DAFF	2	Male
705	DAFF	2	Female		755	DAFF	3	Female
706	DAFF	2	Female		756	DAFF	1	Female
707	DAFF	1	Female		757	DAFF	2	Male
708	DAFF	2	Male		758	DAFF	2	Male
709	DAFF	1	Female		759	DAFF	2	Male
710	DAFF	2	Female		760	DAFF	3	Male
711	DAFF	2	Female		761	DAFF	3	Male
712	DAFF	2	Female		762	DAFF	3	Male
713	DAFF	3	Female		763	DAFF	2	Female
714	DAFF	2	Male		764	DAFF	2	Female
715	DAFF	2	Female		765	DAFF	2	Female
716	DAFF	3	Male		766	DAFF	3	Female
717	DAFF	2	Male		767	DAFF	2	Male
718	DAFF	1	Female		768	DAFF	2	Male
719	DAFF	2	Female		769	DAFF	1	Male
720	DAFF	3	Male		770	DAFF	1	Male
721	DAFF	3	Male		771	DAFF	G	Male
722	DAFF	3	Female		772	DAFF	2	Male
723	DAFF	2	Female		773	DAFF	2	Female
724	DAFF	1	Female		774	DAFF	2	Female
725	DAFF	3	Female		775	DAFF	4	Male
726	DAFF	2	Female		776	DAFF	1	Male
727	DAFF	3	Female		777	DAFF	3	Male
728	DAFF	2	Female		778	DAFF	2	Male
729	DAFF	2	Female		779	DAFF	3	Male
730	DAFF	3	Female		780	DAFF	1	Male
731	DAFF	2	Female		781	DAFF	2	Male
732	DAFF	3	Male		782	DAFF	3	Male
733	DAFF	3	Female		783	DAFF	2	Male
734	DAFF	2	Male		784	DAFF	2	Male
735	DAFF	3	Female		785	DAFF	3	Female
736	DAFF	1	Male		786	DAFF	2	Female
737	DAFF	3	Male		787	DAFF	G	Female
738	DAFF	1	Male		788	DAFF	3	Female
739	DAFF	2	Male		789	DAFF	2	Male
740	DAFF	2	Female		790	DAFF	3	Female
741	DAFF	3	Male		791	DAFF	2	Male
742	DAFF	3	Male		792	DAFF	3	Male
743	DAFF	3	Female		793	DAFF	2	Male
744	DAFF	2	Male		794	DAFF	1	Male
745	DAFF	2	Female		795	DAFF	2	Male
746	DAFF	3	Female		796	DAFF	3	Male
747	DAFF	2	Male		797	DAFF	G	Male
748	DAFF	2	Male		798	DAFF	3	Female
749	DAFF	2	Male		799	DAFF	2	Female
750	DAFF	3	Male		800	DAFF	3	Female

Staff ID	Agency	Level	Gender		Staff ID	Agency	Level	Gender
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802	DAFF	1	Male		816	DNRM	2	Female
803	DAFF	1	Male		817	DNRM	2	Male
804	DAFF	2	Male		818	DNRM	2	Male
805	DAFF	2	Male		819	DNRM	2	Male
806	DAFF	3	Male		820	DNRM	2	Male
807	DAFF	2	Female		821	DNRM	2	Male
808	DAFF	2	Female		822	EHP	G	Female
809	DAFF	G	Female		823	EHP	1	Male
810	DNRM	2	Female		824	EHP	G	Female
811	DNRM	2	Female		825	EHP	G	Female
812	DNRM	2	Female		826	EHP	G	Female
813	DNRM	2	Female		827	EHP	1	Male
814	DNRM	2	Female					

Appendix 8. RDS and Differential Recruitment

Respondent-Driven Sampling (RDS) is a sampling method in which existing sample members recruit new members to the sample from their social network. A key assumption of the method is that the recruitment is random and non-preferential - sample members recruit from their social network with equal likelihood. Yet in a complex fishery with multiple classes of fishers and fishing activities, this assumption may not be met.

This appendix models differential recruitment where some sub-classes of the target population preferentially recruit from their own or another class. We found that this can lead to substantial bias and this bias cannot be detected from the RDS sample alone. Our model suggests that when a simplified variant of RDS is applied to a completely connected population, differential recruitment can lead to arbitrary sample bias. This observation suggests a simple heuristic for computing differential recruitment probabilities that produce an arbitrary bias when RDS sampling from a general population. We go on to demonstrate the effectiveness of this heuristic through simulation.

Although in principle differential recruitment may lead to substantive bias, the degree to which this actually occurs in practice remains to be determined. Ideally the propensity for differential recruitment and the resulting sample bias would have been assessed in the comparative survey of the Tasmanian recreational long-line or rock lobster fisheries, but unfortunately there were too few respondents to the survey to allow a meaningful assessment.

Differential Recruitment and Sample Bias

Respondent driven sampling (RDS) is a chain referral method for sampling from populations for which effectively no sampling frame exists. To begin the process, a set of *seeds* are selected from the target population. The seeds form *wave* zero of the sample. Each seed is provided with a number of recruitment coupons and is encouraged distribute these amongst their associates in the target population. The coupons encourage the holder to contact the sampling agency in exchange for a reward. Those that accept a coupon from a seed and then contact the sampling agency form wave one (or *k*) of the sample. The sampling then proceeds in the same manner - the members of wave k are provided with more coupons to distribute amongst their associates. Those that accept a coupon from a member of wave k and contact the agency form the membership of wave $k+1$, and so on.

Sampling proceeds without replacement, so once a subject has received a coupon they are precluded from accepting anymore. This process can be modelled as a set of self-avoiding branching random walks on a graph (Brémaud, 2017). As RDS samples without replacement these random walks are mutually self-avoiding. The social network of the population is represented as an undirected graph in which the vertices represent population members and the edges social connectivity. The passage of successive coupons through the population can then be represented as the steps of branching random walks along the edges of graph.

Sampling with Replacement on a Complete Graph

To build our heuristic understanding first let us consider sampling with replacement from a target population in which every member is known to every other.

In conventional respondent driven sampling (RDS), once a subject receives a coupon they are not permitted to accept another - in essence the sample is drawn without replacement. If we remove this constraint and allow each subject to potentially accept multiple coupons the resulting sampling process is now *respondent driven sampling with replacement* (RDSWR).
If in addition it is assumed that every participant passes on exactly m coupons and that no coupons are refused then the passage of any sequence of coupons through the population under RDSWR can be viewed as a random walk on the graph and the sequence of vertex colours encountered on this walk forms a k state, discrete Markov chain. We will call this chain the vertex colour chain of the graph.

Take complete graph K_n on n vertices and assign an arbitrary improper vertex k-colouring to the graph (so adjacent vertices may have the same colour), and let $\{n_1, \dots, n_k\}$ denote the number of vertices of each of the k colours. Assign edge weights to the graph so that the weight $w_{ij} = w_{ji}$ assigned to an edge is uniquely determined by the colours i and j of the vertices on which it is incident.

The vertices of this graph represent population members and the vertex colouring partitions the population into k sub-populations (for example non-avid/non-club member, avid/non-club member, avid/club member). The edges of the graph represent the (reciprocal) associations between population members, and as this is a complete graph it assumes every population member is known to every other.

Let the edge weights determine the probability with which one member of the population recruits another. Specifically, if person A holds a coupon, let the probability that person A recruits person B be the weight of the edge AB divided by the sum of the weights of all edges incident to A. If the edge weights are all equal there is no differential recruitment, while unequal edge weights correspond to a preferential recruitment of the corresponding vertex colours.
Calculation show that the transition probabilities of this chain are given by

$$p_{ij} = \frac{(n_j - \delta_{ij})w_{ij}}{\sum_{b=1}^{k}(n_j - \delta_{ib})w_{ib}}$$

where δ_{ij} is the Kronecker delta. Define

$$\pi_i = \frac{n_i \sum_{b=1}^{k}(n_b - \delta_{ib})w_{ib}}{\sum_{a=1}^{k} n_a \sum_{b=1}^{k}(n_b - \delta_{ab})w_{ab}}.$$

Then it is easily verified that

$$p_{ij}\pi_i = p_{ji}\pi_j$$

and hence the chain is reversible with stationary distribution $\pi = \{\pi_1, \dots, \pi_k\}$.

This implies that if a sufficiently large RDSWR sample is drawn that the chain converges, the relative frequency distribution of the colours within the sample will converge to the stationary distribution π.
Direct calculation also verifies that given a k-coloured complete graph with vertex colour frequencies $\{n_1, \dots, n_k\}$, choosing edge weights proportional to

$$w_{ij} \propto \frac{p_{ij}\pi_i}{(n_i - \delta_{ij})n_j}$$

yields a vertex colour chain with transition probabilities p_{ij} and stationary distribution π.

As a Markov chain is entirely determined by the transition probabilities the implication is that given a complete graph with vertex colour frequencies $\{n_1, \dots, n_k\}$, it is possible to construct a second graph with differing vertex colour frequencies $\{n_1', \dots, n_k'\}$ with edge weights chosen so that samples drawn from the two graphs by RDSWR are statistically indistinguishable.
This discussion assumes the sample is drawn with replacement. But for small sampling fractions the probability of a population member occurring more than once in sample when sampling with replacement is low, and sampling with replacement or without replacement should yield similar results. That is, when the sampling fraction is low any bias introduced through differential recruitment when sampling with replacement should also be reflected in a sample drawn without replacement.

RDS on a Random Graph

The results of the previous section do not immediately generalize to sampling without replacement from a random graph.

Let g be a connected simple graph g on n vertices and as before, assign an arbitrary improper vertex k-colouring to the graph and assign edge weights so that the weight $w_{ab} = w_{ba}$ assigned to an edge is uniquely determined by the colours a and b of the vertices to which it is incident.
Again consider respondent driven sampling with replacement (RDSWR), and assume that every participant passes on exactly m coupons and that no coupons are refused. As before, the passage of any sequence of coupons through the population under RDSWR can be viewed as a random walk on the graph, and the sequence of vertices visited by the walk forms an n state discrete Markov chain, with transition probabilities given by

$$p_{ij} = \frac{w_{c(i)c(j)}}{\sum^b w_{c(i)c(b)}}$$

where $c(i)$ is the colour of vertex i, and the sum in the denominator is over the vertices adjacent to vertex i. In this case define

$$\pi_i = \frac{\sum^b w_{c(i)c(b)}}{\sum^a \sum^b w_{c(a)c(b)}}$$

and again it is easily verified that

$$p_{ij}\pi_i = p_{ji}\pi_j$$

and hence the chain is reversible with stationary distribution $\pi = \{\pi_1, \dots, \pi_k\}$.

This determines the distribution with which the **vertices** of the graph will appear in an RDSWR sample from the graph. Knowing the vertex colouring, from the vertex distribution the distribution of colours and transitions between colours in the sample can be deduced and in particular, the probability q_{ab} of observing a transition from colour a to b in the sample will be dependent only on the weight w_{ab}. So in principle it should be possible to determine appropriate weights to reproduce any desired set of probabilities for the colour transitions.

The key distinction with the complete graph case is that for an arbitrary connected graph the sequence of colours encountered through the walk is not a Markov chain. So the sequence of colours is not completely summarized by the probabilities with which colour transitions occur, and sampling processes with identical transition probabilities may not be statistically indistinguishable.

Heuristic method

These observations suggest to a simple heuristic method to determine the weights required to reproduce a desired set of colour transition probabilities $\{q_{ij}\}$ in a given graph g.

1. Initialize the edge weights $w_{ij} = w_{ji} = 1$.
2. Estimate the colour transition probabilities for the current edge weights by drawing RDS samples for the graph and computing the mean colour transition frequencies $\overline{p}_{ij}$.
3. Compute updated edge weights as the ratio of desired and estimated colour transition probabilities $w_{ij} = q_{ij}/\overline{p}_{ij}$.
4. Iterate steps 2 and 3 until convergence.

Simulation

The heuristic derived in the previous section was tested with a simple simulation.

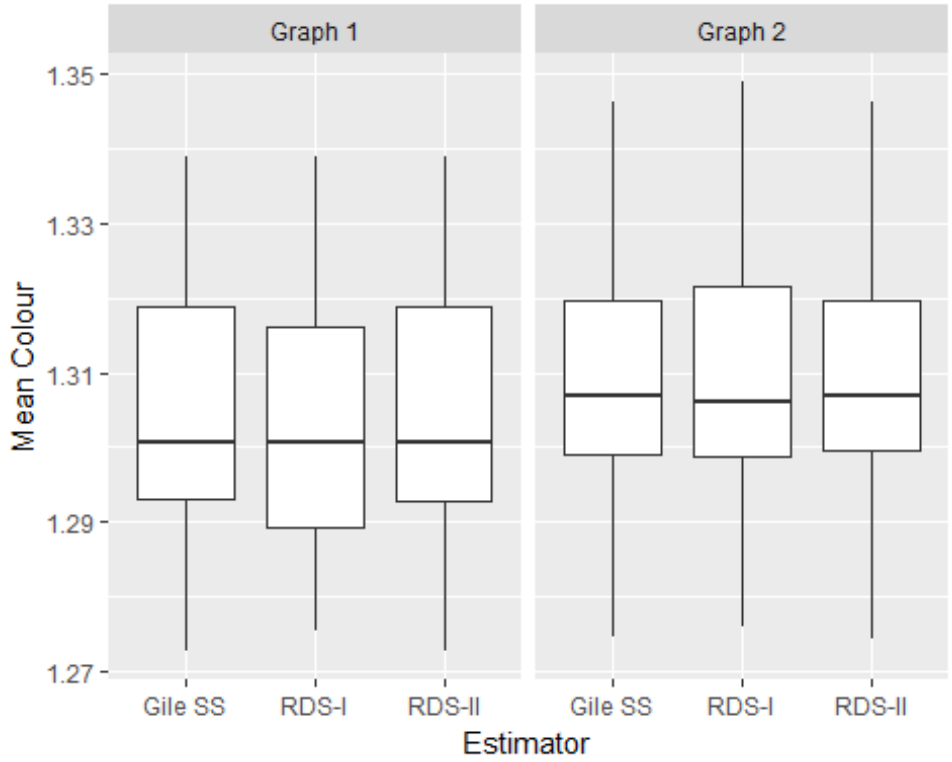
Two random graphs of approximately 5000 vertices were generated. In the first approximately two thirds of the vertices were coloured "1" and the remainder coloured "2", giving a mean vertex colour of 1.306, while in the second approximately one third of the vertices were coloured "1" and the remainder coloured "2", giving a mean vertex colour of 1.612. These two numbers 1.306 and 1.612 represent the true means of our populations.

We used the heuristic from the previous section to determine what edge weight of differential recruitment would be required to cause an RDS sample from the second graph to mimic an RDS sample from the first.

RDS samples were then simulated from each graph, starting in each case with 3 seeds assuming that 10% of recruiters recruit no-one, 50% recruit only a single person and 40%

recruit two individuals. If every chain in any wave expired, additional seeds were generated automatically, and sampling continued until at least 500 participants were drawn.

Twenty five samples were simulated from the first graph with no differential recruitment, and further twenty five RDS samples were drawn from the second graph using the computed differential recruitment edge weights. For each sample the RDS type I (Salganik and Heckathorn, 2004), RDS type II (Volz and Heckathorn, 2008) and Giles SS (Gile, 2011) estimates of mean vertex colour were computed and the results are shown in the following figure.



This figure demonstrates that the differential recruitment of samples that occurred to generate estimates in the second graph have introduced substantial bias. Rather than returning the true value 1.612, mean values less than 1.131 were produced by all the RDS estimators. Sampling with differential recruitment has hence biased the estimates and the researcher would not have been able to detect this from the data analysis.

Summary

The results of the simulation study demonstrate that differential recruitment can be a source of substantial bias in Respondent-Driven Sampling.

Although differential recruitment is clearly problematic, the degree to which differential recruitment occurs in practice in the context of recreational fisheries is still to be established. Ideally the propensity for differential recruitment and the resulting sample bias would have been assessed in the comparative survey of the Tasmanian recreational long-line or rock lobster fishery. Unfortunately the RDS survey of these Tasmanian fisheries produced too few respondents to allow any meaningful assessment, and the degree to which differential recruitment is a problem in a Fisheries context remains an open question.

FRDC FINAL REPORT CHECKLIST

Project Title:	Trial and validation of Respondent-Driven Sampling as a cost-effective method for obtaining representative catch, effort, social and economic data from recreational fisheries		
Principal Investigators:	Shane Griffiths, Tim Lynch, Jeremy Lyle, Simon Wotherspoon, Lincoln Wong, Carlie Devine, Kenneth Pollock, William Sawynok, Anthea Donovan, Mibu Fischer, Sharon Tickell and Chris Moeseneder		
Project Number:	2012/027		
Description:	The primary objective of this project is to trial and validate the chain referral sampling method, Respondent Driven Sampling (RDS), for obtaining representative data from specialised 'hard-to-reach' components of recreational fisheries. One pilot study and two field trial were conducted on three separate populations to test the RDS method. The pilot study targeted the staff population at the Ecosciences Precinct (ESP), Brisbane, using the RDS technique to conduct a staff well-being survey. We undertook a pilot survey to optimise sampling and operational procedures and validate the mechanics of the method. We then conducted two field trials of RDS on the Tasmanian recreational set-line fishery and rock lobster fishery.		
Published Date:	XX/XX/XXXX (if applicable)	**Year:**	XXXX
ISBN:	XXXXX (if applicable)	**ISSN:**	XXXXXXXXXXXXX (if applicable)
Key Words:	Chain referral sampling; hidden population; Tasmanian recreational set-line fishery; Tasmanian recreational rock lobster fishery;		

Please use this checklist to self-assess your report before submitting to FRDC. Checklist should accompany the report.

	Is it included (Y/N)	**Comments**
Foreword (optional)	N	
Acknowledgments	Y	
Abbreviations	Y	
Executive Summary	Y	
– **What the report is about**		
– **Background – why project was undertaken**		
– **Aims/objectives – what you wanted to achieve at the beginning**		
– **Methodology – outline how you did the project**		
– **Results/key findings – this should outline what you found or key results**		
– **Implications for relevant stakeholders**		
– **Recommendations**		
Introduction	Y	
Objectives	Y	
Methodology	Y	

Results	Y	
Discussion	Y	
Conclusion	Y	
Implications	N	
Recommendations	Y	
Further development	N	
Extension and Adoption	N	
Project coverage	N	
Glossary	N	
Project materials developed	Y	
Appendices	Y	

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