Working with the local community to eradicate rats on an inhabited island: securing the seabird heritage of the Isles of Scilly

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Abstract The inhabited Isles of Scilly, 45 km off the south-western tip of the UK, are home to 13 seabird species including European storm petrel (*Hydrobates pelagicus*) and Manx shearwater (*Puffinus puffinus*), for which the UK has a global responsibility. Between 1983 and 2006, the overall seabird population in Scilly declined by c.25%. This decline triggered the establishment of the Isles of Scilly Seabird Recovery Project, a partnership with the aims to reverse seabird decline and engage the local community and visitors in conserving Scilly's seabird heritage. The eradication of brown rats (*Rattus norvegicus*) from St Agnes and Gugh represented the result of over a decade of preparatory work, involving raising awareness and gaining 100% support from the community. The two islands are home to 85 people. Therefore additional, and somewhat unusual, preparations were required (including clearing sheds, communicating with school children and taking precautions to ensure the safety of pets) during the ground-based baiting operation. In 2016 St Agnes and Gugh were officially declared 'rat-free', meaning worldwide this is one of the largest community-based eradications to have been successful. Biosecurity on inhabited islands is complex, so to ensure the project's sustainability, efforts have been community-led. The community has taken ownership of protecting its seabirds, with 100% saying rat removal and the subsequent increase in seabirds has had, or will have, a positive effect on ecotourism, a key source of income for the islands. No less than 68% of the community said their businesses have directly benefited. This project represents a case study for other community-based projects, showcasing how eradications can gain community support and benefit both wildlife and human populations.

Keywords: biosecurity, brown rat, eradication, Gugh, inhabited, public support, St Agnes

INTRODUCTION

The eradication of invasive species from islands has become one of the most important tools for biodiversity conservation but it can also improve local socio-economics, human health and ecotourism. Rodents have been successfully eradicated from islands throughout the world, including a number of UK islands (Bell, et al., 2000; Zonfrillo, 2001; Towns & Broome, 2003; Bell, 2004; Howald, et al., 2007; Bell, et al., 2011; Thomas, et al., 2017; Bell, 2019). Most of these islands have been uninhabited and many consider that islands with significant human populations, an unreceptive local community or occurrence of livestock and domestic animals are unlikely to be feasible for eradication (Campbell, et al., 2015). Given that an increasing number of eradications are being investigated on inhabited islands, the importance of the engagement and inclusion of local communities has been highlighted in a number of recent eradication and research projects (Oppel, et al., 2010; Bryce, et al., 2011; Eason, et al., 2011, Walsh, et al., 2019). The opinions and safety of the local community need to be a priority in any eradication planned for inhabited islands (Stanbury, et al., 2017). Without compliance of the full community, access to properties may be denied which may result in the failure of eradicating every rodent or following the eradication, community members may compromise ongoing biosecurity measures.

Human activities can affect the success of an eradication campaign, particularly waste management, food storage, buildings harbouring rat nesting materials, and limited access to certain areas of the island. On the inhabited UK islands where previous eradications have been completed, they have been staffed by personnel working for the owners of the island, for example Lundy, UK (Bell, 2004) and Isle of Canna, UK (Bell, et al., 2011) whereby the parties involved are working within the confines of employment contracts. This is not the case with community members. Other wildlife control projects may have seen decision-makers 'persuade the community' to accept their decision, e.g. the delayed rodent eradication programme for Lord Howe Island (Australia) whereby many inhabitants felt excluded from initial planning (Crowley, et al., 2017b).

The purpose of this paper is to set out the community involvement through the various stages of the Isle of Scilly Seabird Recovery Project, how the views of the local community were collected and used in the design and delivery of the project to establish and maintain community support and evaluate how successful the project was in achieving this.

Background to 'Isles of Scilly Seabird Recovery Project'

The Isles of Scilly are 45 km off the southwest tip of the UK (Fig. 1). As an island group, they are made up of five inhabited islands (St Mary's, St Martin's, Tresco, Bryher and St Agnes and Gugh) and up to 190 uninhabited islets and stacks (1,641 ha, Parslow, 2007). The Isles of Scilly are nationally important for many species of seabirds, supporting 20,000 birds of 13 native species including the burrow-nesting species Manx shearwater (*Puffinus puffinus*) and European storm petrel (*Hydrobates pelagicus*) (Lock, et al., 2006). Declines of 25% had raised significant conservation concerns about the future of the seabirds on the islands. The Isles of Scilly 'Seabird Liaison Group' (SLG) is a partnership between Royal Society for the Protection of Birds (RSPB), Natural England, Isles

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of Scilly Wildlife Trust (IOSWT), Area of Outstanding Natural Beauty (AONB) and Isles of Scilly Bird Group, working within the 'Isles of Scilly Seabird Conservation Strategy' since 2006 (Lock, et al., 2006; Lock, et al., 2009; St Pierre, et al., 2014). This strategy describes the status and context of the seabird populations on the Isles of Scilly and identifies priority actions including current and future measures to improve the available habitat for seabirds (Lock, et al. 2006; Lock, et al. 2009; St Pierre, et al., 2014). The eradication of brown rats (*Rattus norvegicus*) from St Agnes and Gugh was identified as a priority action to remove the threat of mammalian reinvasion on the neighbouring uninhabited island of Annet and provide the opportunity for Manx shearwaters and storm petrels to breed successfully once St Agnes and Gugh were cleared of rats.

St Agnes (105 ha) and Gugh (37 ha) are two islands connected by a rock and sand bar at low tide and are separated from the island of St Mary's by a deep,1 km wide channel. The main habitats are farmland, ponds, maritime heathland and grassland, rocky shores and sandy beaches (Parslow, 2007). Non-native *Pittosporum crassifolium* and *Coprosma repens* were introduced as part of the flower farming industry as shelter hedges in the late 1800s. There is a pub, a Post Office and shop, two cafes, a campsite and two community halls. Brown rats were accidentally introduced to the Isles of Scilly from shipwrecks in the 1700s and were widespread and abundant across both islands (McCann, 2005). The 'community' of St Agnes is defined as the 85 residents who live full time on St Agnes, plus two part-time residents who live on Gugh for six months of the year in holiday homes.

Prior to and during the period of the 'Isles of Scilly Seabird Conservation Strategy 2006–2013', seabird conservation awareness activities were delivered on the islands through community engagement by RSPB, IOSWT and AONB. These activities were delivered through press releases, articles and presentations updating residents on the outcomes of annual seabird monitoring surveys, seabird youth education, advocacy at the island fetes and beach cleans. These activities represented a decade of preparatory work enabling the community of St Agnes and Gugh to learn about and take pride in protecting its seabird heritage.

Fig. 1 Map of the Isles of Scilly, 45 km south-west off the tip of the UK.

In 2010, the SLG held a workshop on St Mary's, to initially obtain the views of residents on all inhabited islands regarding options for control, eradication and the importance of seabirds. This workshop provided the mandate for the SLG to commission a detailed assessment into the feasibility of eradicating brown rats from St Agnes and Gugh (Bell, 2011a). Due to eradication projects failing on other inhabited island elsewhere in the world (Oppel, et al., 2010), SLG required the feasibility assessment to include social and economic evaluation. It was not known how the community would feel about eradicating rats; whether they would feel the proposed action necessary, or how they would evaluate social, economic and health benefits of such an operation. If a person's values and sensitivities are dismissed, then they will not engage with operational processes which can jeopardise the whole project. The assessment had to focus on obtaining the opinions of all community members. The feasibility assessment was conducted by Wildlife Management International Ltd (WMIL; Bell, 2011a; 2011b)

The 'vision' for the project primarily focused on protecting Manx shearwaters and storm petrels, because rat eradication was considered the only land-based option that would feasibly increase the abundance of these species.

MATERIALS AND METHODS

Feasibility phase

The community firstly needed to understand that *control* of rats was not an option and that eradication was only a viable goal if all parties worked together. The feasibility study therefore set out to ascertain each resident's opinion on whether they would support the eradication of rats, what benefits they would expect for themselves and the community, and what would motivate them to keep the islands rat-free. Face-to-face interviews using a standard questionnaire were conducted with all adults on St Agnes and Gugh. Controversial topics are often better received if personnel are open to discuss less positive outcomes, acknowledging inherent risks and ethical challenges as it allows questions to be voiced and addressed from the outset (Crowley, et al., 2017a).The risks stated were (a) inconvenience (e.g. temporary or long-term changes in waste disposal, pet and livestock treatment), (b) time away from other activities due to volunteer participation during eradication and long term biosecurity and monitoring, (c) adjustment to new regulations (e.g. undergoing rodenticide training), (d) that economic benefits may take time and only apply to some community members, and (e) funding for eradication may come from grant funding, which communities may feel reduces the availability of financial resources for alternative projects.

In order to make their own decisions, community members each needed to have a full understanding of the technical aspects of the rat removal operation, and what their personal role in the project could potentially be. The feasibility assessment incorporated two general community workshops; a combined meeting with the six farmers to discuss the eradication in detail, covering aspects that were specifically relevant to stock, crops and farms as well as face-to-face meetings on each farm; visits to St Agnes School; and face-to-face meetings with representatives from each household. Every resident was asked to provide full details of their willingness to support a potential eradication and any stipulations they had. Achieving complete rat eradication was only part of the process, the legacy of the project was to keep the islands rat-free in perpetuity. The feasibility study therefore also set out to ascertain the willingness of each community member to carry out biosecurity measures in the long term.

Interim phase

While RSPB and AONB continued to deliver education work to invest in on-the-ground community relationships between June 2011 and January 2013, a Project Steering Group and Communications Group were formed.

Start of the project; preparation for 'rat-removal ready' phase

When funding was confirmed, the five-year 'Isles of Scilly Seabird Recovery Project' (IOSSRP) was launched. Two staff members were employed by RSPB, providing continuity for the community at each phase. Through a competitive tender process, WMIL were the successful contractors for rat eradication. Community conservation actions at this stage were named 'rat-removal ready' actions and were focused on reducing potential rat food and harbourage to a minimum, so rats could be easily detected and take bait when the eradication phase commenced.

The IOSSRP recognised the importance of monitoring the response of other species on St Agnes and Gugh following the eradication of brown rats and implemented a monitoring programme for birds, mammals (shrew and rabbits), invertebrates and vegetation. This work was completed under contract by Spalding Associates. Most species benefit from rat eradications on islands, but there have also been unforeseen and negative impacts recorded in several projects around the world (Courchamp, et al., 2003; Towns, et al., 2006; Bell, et al., 2011).

Eradication and short-term monitoring phase

The eradication delivered by WMIL, was a ground-based bait station operation using rodenticide over winter when natural food was minimal (Bell, 2019). Monitoring tools were used to detect any rats not taking bait or avoiding bait stations. Community members were required to assist WMIL with specific eradication activities such as checking bait stations in their own homes and reporting rat sightings. During the eradication phase, WMIL and IOSSRP personnel built good relationships with community members to create the best foundation for well-coordinated actions for on-going biosecurity and potential incursions in the future.

Post eradication monitoring and final check phase

WMIL produced a Biosecurity Plan and returned for a six-week 'final check' phase in winter 2016. IOSSRP personnel trained community members to assist with the monthly checks of the permanent biosecurity stations and surveillance after a 'rat on a rat' (ROAR) call (a 24-hour hotline based at IOSWT where anyone can report rat sign or a suspected rat sighting). A ROAR required a monitoring grid extending 300 m in all directions from the sighting spot with daily checks for a month (and was removed when no evidence of a rat was detected). During the 'final check', questionnaires as part of semi-structured interviews were carried out. The community questionnaire consisted of 22 socio-economic evaluation questions, 14 delivery questions and eight biodiversity questions. Semi-structured interviews represented feedback from the full population of St Agnes and Gugh. Qualitative analysis was deemed the best fit as interviews allow each person to express themselves, including personal narrative, and common themes can emerge (Crowley, et al., 2017a). It is known that successful eradication of rodents has turned some islands into attractions for visitors, facilitating the establishment of local tourism businesses (Oppel, et al., 2010). Therefore, specific questions were asked to ascertain whether tourism or other businesses had benefited on St Agnes and Gugh following the eradication of rats. During these interviews, community members who were able to commit to long-term biosecurity actions were registered with RSPB as Seabird Heritage Volunteers (SHVs) and were provided with additional training and support to complete these actions.

Long-term monitoring phase

The SHVs took ownership of their biosecurity roles to continue to keep the islands rat-free after the formal end of the IOSSRP project. SHV Coordinators were recruited in the community to coordinate these community volunteers and record data from each biosecurity action. An updated Biosecurity Plan for St Agnes and Gugh was prepared by IOSSRP with contributions from SHVs. A Maintenance Plan was written by the partners and the community aspects were 'sense-checked' by the SHVs.

RESULTS

Feasibility phase

All community members valued seabirds and supported the eradication of rats for the protection of seabirds. The collective support for the project was not solely for seabirds but for the added benefits to people (Bell, 2011a; Bell, 2011b). Rats were having an impact on the livelihood, health, enjoyment and lifestyle of the local community as well as the biodiversity of the island (Bell, 2011a; Bell, 2011b). Farmers reported rats were damaging crops and taking or damaging stock food, fishermen reported rat damage to lobster pots and nets and the campsite suffered damage to tents and customer's food and belongings. Over ¾ of residents reported rats entering their houses. It was estimated that rats were costing the St Agnes and Gugh community approximately £15,000 per year (between £10 and £1,000 per household per year), due to purchasing bait and damage to property and goods (Bell, 2011a; Bell, 2011b).

While explaining that *'the decision to carry out the project is yours'*, the eradication methodology and actions were discussed with the community to ensure that they had all the information needed to make the decision of whether to proceed with the project or not. This gave the community an opportunity to air concerns such as finding adequate funding (86% of residents), incorrect waste management causing eradication failure (80% of residents) and community involvement and support (77% of residents). These concerns were addressed or actions to mitigate these concerns were outlined including information on possible funding streams; bespoke waste training at each property, eatery and farm; provision of rat-proof garbage bins and composters; revised process for waste collection and removal to St Mary's; and the communication strategy (including a 24-hour call line).

Interim phase

A number of activities were completed during the interim phase including putting 'Frequently Asked Questions' on project partner websites, addressing community and wider community questions; delivering two press releases; education and outreach activities on how to detect rats and shrews and providing funding updates to the community. Funding applications were completed and included fully-costed mitigation options for identified issues collected during the feasibility assessment.

Preparation 'rat-removal ready' phase

A five-year 'activity programme' was developed for the community and visitors. A full audit of St Agnes and Gugh was carried out in June 2013 to prepare the islands

and provide final 'rat- removal ready' instructions to all residents as requested by the community during the feasibility assessment.

Eradication and short-term monitoring phase

All community members allowed daily access to property for WMIL personnel to carry out the ground-based bait station eradication using rodenticide (either Contrac®, containing the anticoagulant bromadiolone at 0.005% w/w or Roban Excel®, containing the anticoagulant difenacoum at 0.005% w/w) in more than 1,000 stations between October 2013 to March 2014 (Bell, et al., 2019). There was no rat-sign after three and a half weeks (Bell, et al., 2019).

There were no instances of non-target species being affected by the bait (Bell, et al., 2019). Nine rats were picked up above the surface; six of them were discovered by community members, and eradication personnel responded immediately by collecting the carcasses (Bell, et al., 2019). WMIL trained IOSSRP personnel to gain expertise in eradication techniques, which enabled them to further support the community for the later phases. WMIL and IOSSRP personnel delivered the activity programme which included two community update talks, weekly update newsletters and school education sessions.

The eradication methods were reviewed throughout by the Project Steering Group and adaptations were made when necessary. On farms a number of baiting tunnels were dislodged by stock (no bait was consumed) and a number of monitoring stations (i.e. non-toxic flavoured wax) were eaten by cows, so farmers and WMIL liaised to organise a rotation of paddocks where cows would graze, allowing tunnels and monitoring tools to be moved in and out of these areas at certain times and remain intact (Bell, et al., 2019).

Post eradication monitoring and final check phase

Monitoring of the key species showed breeding success for the first time in living memory post-eradication. There were eight Manx shearwater chicks recorded in 2015 and 32 in 2015. Storm petrels returned to breed in 2016 with nine breeding pairs recorded. IOSSRP personnel trained 12 community members to assist checking the permanent monitoring stations and surveillance from 'rat on a rat' (ROAR) calls (Fig. 2).

Fig. 2 IOSSRP personnel train the SHV Coordinators in biosecurity methods. Credit Nick Tomalin.

There were 28 ROAR reports during this post-eradication monitoring phase. Community members assisted the IOSSRP team establish and maintain the ROAR surveillance grid. After the final check was completed, it was deemed appropriate to adapt a ROAR response to the community checking the permanent biosecurity stations only instead of establishing and maintaining a 300 m wide monitoring grid (unless additional evidence of a rat was identified).

The questionnaire responses showed that the entire community felt the eradication had a positive effect on the island and the community (Tables 1–7).When asked what they liked about the project, 31% of the community enjoyed having the eradication team on the islands, 15% liked having no rats on the islands any longer, 10% liked the eradication team and community working together towards the successful completion of the eradication and 5% liked how the project worked closely with the St Agnes School (Table 1). The community thought the project gathered the island together and allowed everyone to work together towards a common goal (Table 2). Half the residents felt that this project had made a positive change to the history for the island including raising cultural awareness of the seabirds and their importance to St Agnes and Gugh and the Isles of Scilly (Table 3). All of the community felt that the project had benefited the economy of the island, with several businesses on the island directly benefitting during and after the eradication (Tables 4 and 5).

Table 1 Response 'themes' from St Agnes and Gugh community members (shown as number of people and percent of the community) to the question 'What did you like about the project?'

Theme of reply	No.	%	Social (S) Biodiversity (B) or Delivery (D) theme
The team being on the islands – nice people to have around	18	31%	S
No rats	9	15%	B
Team and community working together for a common goal	6	10%	S
Team were unobtrusive and respectful which made the experience enjoyable	6	10%	S
The project worked with the school	5	8%	S
Manx shearwaters and storm petrels breeding success	4	7%	B
Team helped me learn about wider island biodiversity	4	7%	B
Learnt about rats and their ecology	2	3%	S
The eradication was professionally delivered	2	3%	D
Like to see the bait-take in real time and the speed of operation in daily updates from the team and in newsletters	2	3%	D
I was sceptical at the start but was proved wrong, complete eradication is possible	1	2%	D

Table 2 Response 'themes' from St Agnes and Gugh community members (shown as number of people and percent of the community) to the question 'Do you think there have been any positive or negative impacts to community by the removal of rats from St Agnes and Gugh?'.

Theme of reply	No.	%
Negative or no impact	0	0%
Positive (no further comment)	16	28%
Positive, community no longer needs to worry about damage caused by rats	14	24%
Positive impacts for farms and visitor accommodation	12	21%
Positive, the project generated interest in the community	7	12%
Positive as it was nice for the community to have the team on the islands in winter	4	7%
Positive, the community was united and not divided in any way, it was a community project	3	5%
Positive, due to the school and children being involved throughout	1	2%
Positive, apart from the increase in rabbits which is negative for farmers	1	2%

Table 3 Response 'themes' from St Agnes and Gugh community members (shown as number of people and percent of the community) to the question 'Do you think there have been any positive or negative impacts to culture/history by the removal of rats from St Agnes and Gugh?'

Theme of reply	No.	%
No impact	29	50%
Positive, as we are making history here on St Agnes	10	17%
Positive impact (no further comment)	7	12%
Positive, culturally we have all worked together as a community	3	5%
Positive, raised cultural awareness of where birds are in our history, memory, collective consciousness, part birds played in our community. Better for historical buildings	2	3%
Positive, as part of our history that we bought rats over and now we are putting our mistake right	2	3%
Positive, we have better waste management and awareness of how to think carefully about staying rat-free	2	3%
Positive, as the project will reinstate historical bird lovers	2	3%
Positive, we can look back and feel proud. I have kept all articles about the project for a community scrapbook to help us remember details correctly.	1	2%

Table 4 Response 'themes' from St Agnes and Gugh community members (shown as number of people and percent of the community) to the question 'Do you think there have been any positive or negative impacts to economy by the removal of rats from St Agnes and Gugh?'

Theme of reply	No.	%
Positive (no further comment)	17	29%
Positive in respect to what other community members have told them, but not personally to them	12	21%
Farmers and/or fishermen will not lose profits from rat damage	8	14%
The project itself brought extra business to the islands (using accommodation/ shop/boats)	6	10%
Don't have to spend money on rat control and damage	5	9%
More boating/bird tours	4	7%
More visitors due to not having rats in lets/tents	3	5%
More visitors in the future if we market the islands as 'rat- free'	3	5%

Table 5 Response 'themes' from St Agnes and Gugh community members (shown as number of people and percent of the community) to the question 'Has your business benefited from this project?

Theme of reply	No.	%
Not applicable	19	32%
No longer have to worry about rat damage to any goods	12	20%
More tourists in holiday lets and accommodation as a result of media exposure	4	7%
Profit in the shop, accommodation	3	5%
Business is now more hygienic and safe for visitors without rats	3	5%
The project team used the boats more, visitors on wildlife trips have increased by 200%, there has been more publicity through the project	3	5%
Yes (no further comment)	3	5%
Composter and bins provided by the project have benefited business	2	3%
Tourists have a more positive experience on the islands	2	3%
Yes, more visitors camping and buying ice-cream as they know the campsite is rat-free	2	3%
The WMIL team using holiday lets	2	3%
Possible knock-on effect as more visitors	1	2%
Guests are actively interested in the project, improving their stay	1	2%
Team bought eggs	1	2%
'Lifelong learning' has benefited from walks and talks	1	2%

Table 6 Response 'themes' from St Agnes and Gugh community members (shown as number of people and percent of the community) to the question 'Do you think there have been any positive or negative impacts to tourism by the removal of rats from St Agnes and Gugh?

Theme of reply	No	%
Positive (no further comment)	14	24%
Positive in respect to what other community members have told them, but not personally to them	4	7%
Positive, visitors' experience of the islands could be negative due to rats in tents/lets/on beaches	21	36%
Positive, more birdwatcher and tourists will visit to see more seabirds	12	21%
Positive if we market being rat-free more to visitors	4	7%
Positive, already heard good feedback from visitors	2	3%
Positive, the project has already promoted the islands as a travel destination, tourists told me they were here as they saw the project/islands on BBC Countryfile	1	2%
Positive, seabird boat tours have had far more visitors onboard due to the project, my business has a 10% increase in turnover due to the project	1	2%

Table 7 Response 'themes' from St Agnes and Gugh community members (shown as percent of the community) to the question 'What support will you offer the project?' asked in 2010 (during feasibility phase questionnaires) and 2017 (long-term monitoring phase).

Theme of reply	% of community members changed from 'No' in 2010 to 'Yes' in 2017 (descending order)
In-kind logistical support	59%
Other (mainly in-kind support such as lifts in vehicles)	58%
Volunteering time	55%
Training in rodent detection and identification	41%
Long-term monitoring for rodents	37%
Training in interview and site inspection procedures and methods	30%
Assisting with any contingency operation	22%
Check for rodent damage to your own cargo	19%
Written support to decision makers (e.g. funders, councillors, MPs).	19%
Listed as a reporting location (where any rat sighting is reported to you for action)	17%
Transporting food to and between islands in rodent-proof containers	17%
Installing and maintaining a bait station on your vessel and/or property	13%
Partner to the project	No change
Financial support	No change

Long-term monitoring phase

Legacy workshops held in 2016 confirmed the role of the SHVs in the on-going biosecurity of St Agnes and Gugh. Quarterly biosecurity monitoring completed by the community SHVs to date has not detected any rats (J. Peacock, St Agnes, pers. comm.).

DISCUSSION

Feasibility phase

Community 'stipulations' or requirements to address concerns were developed following the questionnaire and face-to-face interviews.

The community requested updates on funding opportunities, waste training and provision of bins and composters, a bespoke audit of actions to get the islands 'rat-removal ready' and clear communication lines between the eradication team and the community through community talks, face-to-face dialogue, newsletters and school education visits.

As most residents had concerns over the health and safety of the children, a 'school education day' was delivered whereby school children saw snap traps, bait, tube and lockable bait stations and received training on how to stay safe (Fig. 3). Concerns about personnel whom residents didn't recognise being on their land were resolved by WMIL suggesting that all personnel wear an identifiable uniform (i.e. blaze orange hats with the project logo). Concerns over where the money for travel and subsistence for the eradication team would be spent were answered by WMIL assuring residents that much of it would be spent on St Agnes and Gugh using local providers (i.e. purchasing milk and eggs from the local farmers and supplies from the St Agnes Store). Concerns were also expressed over the potential poisoning of non-target species, particularly pet cats (24 were present during operation) and dogs (four were present). The safety of pets is always a concern to owners, so the mitigation information was provided sensitively, including explanation of the unlikelihood of accidental poisoning due to the design of the bait station and unlikely access to the rodenticide. Pet owners were given information that the antidote to the anticoagulant rodenticide (vitamin K injections and tablets) would be stored on St Agnes, with WMIL personnel being contactable 24 hours a day throughout the operational phase to administer the antidote if necessary. Residents were asked to alert eradication personnel of any dead rats found above the surface so the carcasses could be retrieved immediately.

Several residents raised the issue regarding the possible impacts of rat eradication on the wider ecology of the islands; in particular in regards to the endemic 'Scilly shrew' consuming bait; rabbits consuming bait during the operation as well as potentially increasing rapidly after the eradication; birds eating the bait; cats prey-switching from rats to other species such as birds. WMIL explained the long-term monitoring and mitigation options for these species such as providing diet information for Scilly shrews (insectivorous diet as opposed to cereal-based diet); mitigation methods for rabbits including additional wires on either side of the bait stations to reduce access, and rabbit control by the community as necessary after the eradication; mitigation methods for birds including bait station design preventing access; and mitigation methods for all non-target species including daily careful monitoring of bait blocks for signs of non-target species consumption, re-sighting of bait stations and the use of 'crow-clips' (which further prevent entry by birds such as gulls and corvids). It was recommended that no new cats come to the island if previous cats were originally

kept as 'ratters', and collars and bells should be used for all pet cats. Two residents also struggled with the ethical dilemma of eradicating a species but decided that the threat to seabirds was of larger concern, and the complete eradication of rats was the only viable solution to remove the threat to seabirds on the islands.

The feasibility report (Bell, 2011a; Bell, 2011b) detailed the 'technical conservation actions' required and confirmed that the entire community on St Agnes and Gugh were supportive and willing to carry out general and bespoke actions.

Start of the project; preparation for 'rat-removal ready' phase

Before the eradication phase, the community helped complete a number of required actions including the cessation of any baiting for 12 months prior (snap traps were supplied for local control). Livestock food and bedding on the six farms was reduced to minimum levels and rat-proof feed storage systems were implemented. To ensure there were no areas without bait, livestock pens, paddocks fences, windbreaks and stone walls were mapped using GIS to ensure complete bait station coverage. Where possible, farmers carried out these necessary actions, but any work not completed was carried out by WMIL and IOSSRP personnel the month before the eradication.

Residents' waste management practices were improved by the provision of new bins and composters as part of 'Bin Friendly Days'. 'Shed clearance days', 'beach clean days' and 'wood collection and bonfire night' reduced rat food and harbourage around the islands. The St Agnes School held an 'Apple Day' to remove wind-fallen apples from the ground. Rats were trapped for resistance testing to confirm final bait choice for the eradication. Index trapping results estimated the rat population on St Agnes and Gugh to be between 3,000 and 3,500 rats. Any restrictions or sensitivities in regard to accessing peoples land and properties was obtained.

Fig. 3 Bait awareness workshop with St Agnes School children.

As entrance to St Agnes and Gugh via boats is not regulated by any authority, this presented the highest risk pathway for biosecurity. Talks to all community members and the Harbour Users Group (for all boat users on Scilly) regarding biosecurity requirements and vigilance were held throughout the project.

Eradication and short-term monitoring phase

The contractors, team members and community members worked well together to ensure complete eradication of rats which would be confirmed after a further two-year check.

Post eradication monitoring and final check phase

Various themes emerged from the post-eradication interviews which are summarised in Tables 1–7, including:

Social: The entire community felt the project had positively affected their day-to-day life. A strong theme was they no longer needed to worry about rats *"They used to be on my mind, worrying about where they are and what they do"*. Most of the community (86%) felt the removal of rats had improved health due to the reduction of diseases spread by rats. When asked 'what did you like most about the project?' eleven themes developed with social-themed responses being most popular (Table 1). When asked 'what did you dislike most about the project?' the answer 'nothing' was overwhelmingly the most popular answer with three other themes (increase in other nuisance species, ethical dilemma and concern about accidental pet poisoning) being mentioned, however they felt that each concern had been mitigated against (Table 1). When asked if the project had any positive or negative impacts on the community, 100% answered 'positive' (Table 2). One theme that stood out was that '*the community was united and not divided*

Fig. 4 WMIL training community member to store bait box safely. Credit Alastair Wilson.

in any way, it was a community project'. When asked if there had been any impacts to culture and history (Table 3), one person said, "*It has raised cultural awareness of where birds are in our history, memory, collective consciousness and the part birds played in our community".*

Economy: Again, the entire population felt the project had benefited the local economy (Table 4), with most of this benefit to certain sectors; agricultural, fishing and particularly tourism and that the benefits had potential to increase. Over two-thirds of the community (68%) felt that their businesses had benefited from the project (Table 5). A section of the community (17%) had developed new products; e.g. one farmer explained that '*Apple day had been the catalyst to a new apple juice product and cider products he developed'*. Another community member explained that *'visitors on his 'boating wildlife trips' had increased by 200%, as there has been high publicity of the project, combined with interpretation resources, so he could offer improved tours"*. Publicity was an added benefit to the project, which was not originally anticipated by the IOSSRP 'activity programme'. Shows such as BBC 'Countryfile', BBC 'One Show', BBC 'Springwatch' and a German wildlife show, were viewed by approximately 20 million viewers in total (pers. comms.) and directly led to increased tourism with one community member saying '*A tourist told me they had visited due to seeing the project on BBC 'Countryfile'.* Tourism generates the largest income on the island (Blue Sail, 2011), and 100% of the population felt the project had a positive impact on tourism (Table 6).

Interestingly, once rats had been eradicated, more residents (94% in 2016 compared to 76% in 2010) recognised that they had been having a greater issue with rats than first thought, regarding damage, and on reflection the cost rats had caused them was revised as being higher (Table 7).

Biodiversity: Compared to the 2012 questionnaire, the number of residents being sympathetic to seabirds had increased by 47% (Table 7). Regarding the wider species present on St Agnes and Gugh, none of the community felt that the eradication of rats had any negative impact on any non-target species.

Project procedures and delivery: All of the community were happy with the project procedures and methods (Table 1). When asked if it was helpful having WMIL team members assisting 'rat-removal ready' action 'shed clearance' one person said: *'it generated goodwill in the community and got everyone on board with the project'.* When asked whether the different communication methods were correct, the entire community said yes. Common themes were, '*clear explanation of what we needed to do and when*', '*involved everyone and engagement with all children at the school*', '*the team was passionate about the cause*', '*we felt listened to, as things were altered if we asked for them to be*'.

The final questions asked what support the community could give to future biosecurity to keep the islands rat-free. More residents were willing to offer support compared to 2010 (Table 7). An additional 20 community members said they would volunteer to assist biosecurity monitoring, due to being proud of the project and wanting to play their part to keep the island rat-free. A total of 32 community members have registered with RSPB as 'Seabird Heritage Volunteers' (SHVs).

Long-term monitoring phase

The role of the SHVs was confirmed as covering five tasks; (1) checking permanent monitoring stations once a month; (2) sustaining biosecurity on boats and freight; (3) carrying out surveillance for potential incursions (within 24 hours of a 'ROAR' call'); (4) assisting with incursion response baiting; and (5) assisting with the ecological monitoring of the key species.

Each SHV received LANTRA rodenticide training as well as bespoke training for incursion response protocols; a social media (Facebook) group was set up as a mechanism to send monthly check information to the SHV coordinator; biosecurity protocols were reaffirmed; and incursion response methodology was revised (i.e. check all biosecurity stations within 24 hours of a 'ROAR' especially those with the stations nearest to the report location and report back to the SHV coordinator) and tested by a 'mock incursion response' exercise.

If rat-sign is found at any time in the future, the SHV coordinator will inform IOSWT on St Mary's and the RSPB Conservation Officer in Penzance. The SHVs will swap monitoring wax for rodenticide in their biosecurity stations within 24 hours and report any new rat sign. An RSPB-coordinated incursion team will arrive to assist incursion response baiting for one month, with the SHVs assisting where possible.

In addition to biosecurity monitoring, SHVs assist IOSSRP personnel and IOSWT contractors to survey Manx shearwater and storm petrel breeding sites (using play-back at burrows) and 'evening chick-check walks'.

The IOSWT has committed to fund the work outlined in the 'St Agnes and Gugh Maintenance Plan', including, but not limited to, ongoing biosecurity training for the community, seabird surveys and resources required to keep the biosecurity shed functional.

CONCLUSION

The success of this project was due to three factors; the vision for the sustainability and legacy of the project from concept; robust preparation; and being 'community based'. Community members joined decision-making processes from the offset, and in advance of this, a decade of preparation activities meant relationships had started to be built and methods on how to protect seabird heritage had started to be shared. These relationships then sustained trust through the 'rat-removal ready actions' and eradication phase, enlisting an excellent contractor and team whom worked with the community addressing all stipulations, and having available, adaptive project staff to accommodate community concerns when required. Community members therefore felt listened to and valued.

The IOSSRP experience shows that, to ensure that an island restoration project on an inhabited island runs successfully, the support and agreement from the community must be secured. It is vital that access to all properties is obtained to effectively carry out an eradication. The community must share the project's vision and feel that they are one of the beneficiaries. To do this, they will need to be included in the decision-making process and management of the project. In this way the legacy of the project will be much stronger. The larger the community, the longer, potentially, the project managers will need to ensure that the residents are all at the same position of understanding through the various stages of the project. Archipelagos or groups of islands bring additional stakeholders and interested parties that need to be engaged compared to single islands. Ten years is not an unreasonable timescale depending upon the starting point, the value placed upon seabirds by the community, and the strength of the project partnership.

It is important to recognise the social science requirements for eradications planned on inhabited islands. The views and concerns of each and every resident and stakeholder group are important. Community engagement and consultation should be completed during every stage of an operation. Most importantly, all aspects of the eradication should be debated with the community in the early stages of the proposal. Unlike eradication operators, most members of the public do not have any knowledge of

the principles and techniques of an eradication, particularly in regard to rodenticide choice and operational procedures. It is important that each community member understands these aspects and how they will be affected by the day-to-day operational requirements. A lack of public awareness about invasive species impacts and misunderstanding of eradication techniques from island communities are thought to have been responsible for the opposition of proposed eradications on inhabited islands around the world and investing in greater education and consultation effort can ensure a suitable environment for eradication projects to proceed (Bryce, et al., 2011).

The additional, and more unusual, preparations which were required on St Agnes and Gugh (e.g. clearing sheds, communicating with school children and taking precautions to ensure the safety of the community's pets) were essential and would have contributed to what was effectively a three and half week eradication period. Maybe even more importantly, was that these activities were a possible turning point for the community, where they recognised what was involved for the whole project to be successful. The methods used in this project ensured the community knew that staff and community were part of a team striving for the same goal, which would be challenging, but rewarding for birds and people.

The defining factors underpinning the success of the IOSSRP were the professional management of the eradication, dedicated and passionate volunteer team involvement, efficient and systematic monitoring, adapting to local conditions and ensuring a community-inclusive approach. The trust and knowledge the community gained during the preparation and eradication phase paired with the positive impacts the eradication of rats had on the seabirds and socio-economics for the community turned into 'pride and ownership' of *their* project.

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