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Crowdfunding conservation science: Tracing the participatory dynamics of native parrot genome sequencing

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Abstract

Who gets to practice and participate in science? Research teams in Puerto Rico and New Zealand have each sequenced the genomes of parrot populations native to these locales: the iguaca and kākāpō, respectively. In both cases, crowdfunding and social media were instrumental in garnering public interest and funding. These forms of internet-mediated participation impacted how conservation science was practiced in these cases, and shaped emergent social roles and relations. As citizens 'follow', fund, and 'like' the labour of conservation, they create new relational possibilities for and with science. For example, the researchers became newly engaged and engaging by narrating and displaying the parrots via an internet-inflected aesthetic. The visibility of online modalities shifted accountabilities as researchers considered who this crowdfunded work answered to, and how to communicate their progress and results. The affordances of the internet allowed researchers from the peripheries of the scientific establishment to produce genomic knowledge for globally dispersed audiences. The convergence of genomic and internet technology here shaped scientific practice by facilitating new modes of participation – for laypeople in science, but also for scientists in society.

Introduction

Each year the people of Aotearoa New Zealand[1] set their sights on a contest matched only in popular interest, perhaps, by the nation's general elections. Bird of the Year sees the country's native birds and their advocates petition the wider population to grant them this competitive national title. For weeks, newspapers report on the polls, and social media becomes a parade of memes, celebrity endorsements, and occasionally slander. The contest has suffered fraud (the 2017 vote tampering scandal) and elevated once-neglected species to the pedestal of national admiration. It is an example of the use of the internet in service of an almost unquestionable good: endangered species conservation. Bird of the Year is also an example of public participation in science facilitated by the visual and connective capacities of social media. From flippant IFLScience memes (https://www.iflscience.com/) to ambitious citizen science projects, the internet is often imagined as a tool for engaging non-experts in science (Strasser et al. 2018).

Here we ask how internet-mediated participation – specifically, crowdfunding and social media – is transforming how conservation science is done, and what social relations emerge. Our focus is conservation science, an interdisciplinary field that works to preserve and enhance biodiversity and in which citizens have long played a role. A cadre of conservation researchers have used crowdfunding and social media to rally support and funding for species of scientific importance. The emergence of crowdfunding platforms specifically for science (e.g. Experiment.com) testifies to the increasing appeal of such methods. From one vantage this is an unsurprising response to increasingly competitive research funding; instead of competing for the favour of a small group of experts, researchers can compete for the attention, affection and interest of geographically diffuse publics, inviting alternative valuations of their projects and ideas. This turn towards digitally-brokered public support also fits with government-mandated imperatives for experts to engage and communicate with broader publics. In principle, crowdfunding allows scientists to engage and fundraise in one deft move. From another perspective it represents an gradual shift in the social position of science, and relations between scientists and publics.

In what follows, we present two conservation genomics projects for native bird species, focussing on the forms of engagement that emerged between scientists, their avian subjects, and broader publics. Based in Aotearoa and Puerto Rico, these projects demonstrate how science takes shape when allied with public interest in the most literal sense: as citizens 'follow', fund, and 'like' conservation science, they create new relational possibilities for and with science. Paying attention to how scientists talk about their audiences, and their use of crowdfunding and social media, we argue that the participatory valence of contemporary conservation science generates new aesthetic, accountable, and geographic relations between science and society.

Science, social media, and the participatory condition

The 'participatory condition' describes how "participation – being involved in doing something and taking part in something with others – has become both environmental (a state of affairs) and normative (a binding principle of right action)' (Barney et al 2016, vii). This shapes a 'promise and expectation' (Barney et al. 2016, viii) that we can meaningfully engage in our social, political, and epistemic circumstances. Through internet platforms, we can participate in everwidening social spheres, and as we do, participation becomes increasingly *virtuous*, associated with ideals of equality, community, and freedom. Thus, participation becomes a 'social, political, and economic resource' (Barney et al. 2016, ix). Although *facilitated* by digital technology, Barney et al. note that the participatory condition arises from long-standing historical and political trends in the West: democratic ideals, compatibilities between participation and neoliberalism, the evolution of 'participatory' artforms and mass media. Indeed, the problems and possibilities of participation are 'restaged' (xviii) repeatedly as media evolve. However, the (Silicon Valley-inspired) vision of the internet as a non-institutional, anti-hierarchical, flexible space of participation has made it a powerful locus of technological imaginings around participation.

STS (Science and Technology Studies) scholars have critiqued the celebratory ideals associated with participation, showing that often, the internet offers new garb for old formations of labour and knowledge production (Irani 2015, Wark and Wark 2019). Participation has received similarly critical scrutiny. The enrolment of non-experts in knowledge production is firmly institutionalised across liberal democratic settings (Kurian and Wright 2010), serving as a presumed route to accountability (Jasanoff 2003) and safeguard against failures of public trust (Wynne 2006). This shift emerged in the 1990s from a realisation that without societal buy-in, scientific developments could be derailed (c.f. Wynne 1992). Participatory possibilities have also expanded with new forms of play and engagement, from DIY biology (Calvert 2013) to digital and bio-hacking (Coleman 2012; Delfanti 2013; Roosth 2018). The citizen science movement, for instance, draws on both participatory ideals and histories of hacker and open source movements to invite lay people into scientific enquiry (Fan and Chen 2019). However, attempts to “democratize” science have often not enhanced trust nor created more responsible technologies (Chilvers and Kearnes 2019).

Genomics exemplifies both the promises and shortcomings of public engagement with science. Participation is encouraged through sharing biospecimens, data, and genealogical information, evidenced in the enthusiasm towards consumer genomics platforms such as 23andMe. The scale of genomic data has necessitated sharing and coordination between sites. And though genome scientists were early adopters of open data standards and protocols such as the Bermuda Principles (Jones, Ankeny, and Cook-Deegan 2018; Stevens 2015b), such information flows also created new winners and losers in the distribution of scientific knowledge and power (Hilgartner 2012). Along with the diminishing cost of DNA sequencing, these factors laid the groundwork for greater public participation in genomics, while also permitting consumerism, data extraction, and bio-surveillance (Zwart 2009; Zuboff 2019). Concurrently, open data and open science movements have gained traction (Delfanti 2013). These capitalise on forms of openness enabled by both science and the internet, creating a ‘double appeal to science as both origin of openness and in need of more’ (Kelty 2012, 159).

Though often imagined as synonymous with accountability and good science, injunctions of openness can also re-entrench flows of scientific and financial resources towards already-powerful actors (c.f. Hilgartner 2012, Hinterberger and Porter 2015). These ambivalent affordances of science and the internet map onto uneven geopolitical terrain (Shrum 2005). For example, Rodriguez-Medina and colleagues (2019) show that digital connectivity can connect researchers across North-South divides without actually giving more peripheral researchers meaningful influence over the direction or purpose of research. This raises questions about how new digital technologies and scientific norms might modify the figure of the scientist. If the personage of the scientist evolved from academic to bureaucrat to scientist-entrepreneur over the twentieth century (Shapin 2008), will new digital tools reshape what it means to be scientific today?

If the participatory condition denotes a broader orientation towards participation as mode of living, this article considers two very specific expressions of that condition: laypersons funding and 'following' research online, and researchers in turn engaging with those supporters by sharing updates, images, and other research-related 'content'. This is but one manifestation of citizen science (Dosemagen and Parker 2019) and one approach to understanding participation in conservation science. Volunteers have been instrumental as members of formal scientific projects (Whitney 2013a) and as instigators of research on understudied or politicised environmental phenomena (Breem et al 2015); they are also part of the broader economy of commercialised conservation-as-ecotourism that characterises much contemporary conservation (Lorimer 2010). Conservation science writ large is thus shaped by the 'participation' of diverse groups, and some fields (e.g. ornithology (Whitney 2013b)) have long histories of involvement of laypersons in research practice.

In contrast to these studies of participation as on-the-ground activity, we explore the specific participatory dynamics at play in two examples of crowdfunded conservation genomics. This paper is based primarily on our analyses of media coverage, scientific literature, and online material produced by the research groups in question. As a result, although scientist-publics relations are central to this account, our focus is on how scientists represent and engage in these relations, rather than public motivations. The kākāpo case also draws on a small interview-based (n=11) project examining the uptake of genomics in conservation science in Aotearoa.[1] We show how crowdfunding for native parrot conservation produced new relations between scientists and diverse publics, who collaborated online in pursuit of species protection. Scientific subjectivities and the organisation of contemporary conservation genomics alter when science goes online; we read this as part of a broader, societal participatory impulse.

Kākāpō

[1] Interview material is primarily used to add context about conservation in Aotearoa, but one interviewee was a member of the Kākāpo Recovery Project, and his insights accompany the textual analyses that form the backbone of this piece.

The kākāpō parrot is a nationally beloved icon of Aotearoa New Zealand[2]. The species is flightless, having evolved in a context entirely free of predators. Instead, kākāpō clamber along the ground, nest in burrows, and climb trees using an inelegant choreography of beak and feet. This is the world's only flightless parrot, potentially its longest lived, and certainly its heaviest, weighing up to four kilograms. Their large eyes, whiskery faces, and nocturnal lifestyles have earnt them the nickname 'owl parrot'.

Figure 1: Kākāpō Elwin in a rimu tree
Photo by Andrew Digby

After the kākāpō subfamily (Strigopinae) split from their last common ancestor between 85 and 28 (Rheindt et al 2013) million years ago, they enjoyed a long period of abundance. While early Polynesian settlers killed kākāpō for meat and their decorative feathers, the birds were plentiful upon Aotearoa's 18th Century colonisation (Bergner et al 2016). Of the many colonial violences that followed, the introduction of mustelids (specifically stoats) was, for kākāpō, the worst. Introduced predators decimated the parrots. By 1995, only fifty-one known kākāpō remained, although a population of 200 was later found offshore (Hamill 2003). In genetic terms this was a damning loss of diversity.

Today, the species is managed by the Kākāpō Recovery Programme (KRP), a subsidiary of New Zealand's Department of Conservation (DOC). The KRP face typical public sector constraints, arising from an increasingly neoliberalised conservation context (Dinica 2017, Moloney 2014), and exacerbated by a nine-year National Party government (2008-2017) that froze DOC's budgets (DOC 2018, Matthews 2013), 'restructured' repeatedly (DOC 2011, 2013), and pushed what interviewees called 'clean toilets conservation' (i.e. tourism) (see also Dinica 2017). In interviews, conservation scientists roundly critiqued this funding environment, which they saw as directly compromising native species' security. Nonetheless, the KRP maintains a monitoring and conservation strategy that seeks to maximise the health of individual birds, and the reproductive rate of the population. Every kākāpō has a name and a personalised feeding station that monitors its weight and only releases food to the right bird. The birds live on four predator-free islands, and are moved around so the most genetically compatible individuals can breed, maximising future genetic diversity. Historic bottlenecks saw populations founded from only a couple of individuals, so the KRP work to ensure no one bird's genes are over-represented in subsequent generations. This population-level 'genetic management' is central to their work.

Until 2019's bumper breeding season, more kākāpō genomes existed than kākāpō themselves. The first genome was sequenced in 2015 at Duke University, as part of the Vertebrate Genomes Project. This became the species' reference genome. Shortly after, a KRP researcher suggested sequencing the entire population; there were, at the time, only 125 birds. They hoped that genomic insights might illuminate the bird's low hatching success, or the disease plaguing them (cloacitis, or 'crusty bum'). Though a population of 125 placed kākāpō squarely in the critically endangered bracket, it was an expensive number of genomes to sequence. This was true even though the reference genome allowed for lower resolution sequencing of subsequent birds, making the 125 genomes each significantly cheaper than the first. The cost was prohibitive for a government-funded conservation group. However, the KRP have one advantage in the context of New Zealand conservation: they work on a particularly charismatic and beloved species.

@Spokesbird

The cultural presence and charisma of kākāpō is evident online. Since 2009 the species has been represented by its most famed member, Sirocco. Sirocco 'tweets' (@Spokesbird) to some seventeen thousand followers. His Twitter bio reads:

> I'm a cheeky, rare kākāpō parrot. I got famous for doing crazy things on TV. I now use my celebrity for good, as New Zealand's official Spokebird for Conservation.

Those 'crazy things' include a now-viral video of Sirocco enthusiastically trying to mate with a cameraman's head, narrated by the British television celebrity Stephen Fry. The event lives on in memes immemorial, and Sirocco clearly made a lasting impression on Fry, who endorsed kākāpō for Bird of Year 2018 via Twitter. Sirocco's Twitter account shares his movements (he sometimes tours the country for outreach), kākāpō news, fan art, and updates about Aotearoa's other native species. The kākāpō's internet presence expanded further when Google donated $8000 to the KRP in 2017 (Wong 2017). A subsequently developed Google Earth feature (https://bit.ly/2oryIc0) allowed people around the world to virtually tour several key kākāpō conservation sites, including their offshore island homes. David Attenborough provides a voiceover introducing the species and the conservation efforts supporting them.

Kākāpō Recovery also found a useful platform on social media. On their Facebook page, the research group share photos of the birds and the field (scenic islands, accessible only by chartered helicopter), research updates, and affectionate observations about particular birds. This is an often humorous, boots-on-the-ground image of conservation science that clearly engages a sector of the >50,000 people who 'like' their page. The scientists' Twitter platform is similarly compelling, with images, stories, updates, and video all keeping followers up to date on the latest kākāpō news.

Another important platform for conservation and kākāpō is the KRP's website. Here people can 'adopt a kākāpō', contributing from 250 to 500 New Zealand dollars to a specific bird, and receiving in return an adoption certificate, soft toy, stickers and a bookmark. The webpage displays a photo of each adoptable bird, alongside their name, where they were discovered or born, and details of their personalities, habits, and genetic importance. 'Felix', the website states, 'is one of the most successful males in the kākāpō population. He mated about eight times during the summers of 1997 and 1999… We must be careful not to let Felix's genes dominate the next generation, because it could lead to inbreeding problems. We're not sure why Felix is such a hit with the females' (Department of Conservation n.d.).

During an interview a KRP member noted that most of the Program's donations come from outside Aotearoa. In one account, an American kid requested donations for kākāpō instead of presents for their birthday. Such stories testify to the power of this charismatic species (Lorimer 2007). Their charisma combines with the birds' online presence to mobilise support from even those people who will likely never see a real kākāpō. Digital platforms allow people to be enrolled into supporting this rare and endangered species, to such an extent that international donors comprise a significant source of support for kākāpō. This national icon is upheld by a digitally-mediated network of international carers, who share their money and attention in response to the sharing of kākāpō imagery and information. The kākāpō's cause is further helped by leveraging celebrity influence from the likes of Fry and Attenborough.

Here the "visual economy of conservation" (Reinert 2012) turns the image of cute and personable – but endangered – kākāpō into the support needed to stave off its extinction. By adapting to the aesthetic and modalities of social media, the researchers experiment with a participatory stance that allows them to contribute to the circulation of animal imagery that is ubiquitous online, while simultaneously inviting limited forms of participation in their research activity. Through a conjunction of celebrity, social media, and tech giant sponsorship, a rare flightless parrot that is confined to a handful of deep South islands developed a presence that spans the globe. Crucially, it is not just the parrots whose image and influence travels: the science that sustains them is part and parcel of their online presence.

Crowdfunding kākāpō

The KRP capitalised on this charisma and public profile when drumming up support for their population sequencing. Realising that the undertaking was impossible within their budget, the

KRP turned to crowdfunding, hoping to raise $45,000. In 2016, they partnered with the Genetic Rescue Foundation, a non-profit that supports the use of genetics in conservation. This group assembled a team comprising Te Rūnanga o Ngāi Tahu (the tribal council of Ngāi Tahu iwi[3]), researchers from Duke University (US) and the University of Otago (NZ), and NZ Genomics Limited, a genomics services supplier. The Foundation created a page on Experiment.com, an online crowdfunding platform expressly designed for scientific research.

Experiment.com operates through an all-or-nothing pledge model: scientists set a funding target and create a page detailing their project; 'backers' pledge a sum of money, and the transaction only proceeds if the funding target is met. The website states this model delivers money straight into researcher's hands, circumventing the overheads that universities subtract from traditional grants. Experiment.com takes 8% of the return on funded projects, plus operating costs. ('Experiment is a mission-driven for-profit company. Though really, we're a happy melting pot of science, social entrepreneurship, and technology startup.') Backers receive project updates and get to virtually join in the discovery process.

Experiment.com is organised around an ethos of transparency and openness. Their 'Our mission and values' page states: 'We believe that science is a public good and should therefore belong to the public', and 'Openness makes us smarter'. As the website states, 'Experiment works because project creators give scientific results back to the funders. Researchers share pictures, updates, datasets, pre-prints, protocols, and papers' (Experiment.com 2019). The platform's structure elicits reciprocal participation from both the scientists and the funding public. In the case of Kākāpō 125, as the sequencing project was called, the fundraising team answered questions and responded to comments made on the page, providing a palpable connection between backers and the researchers.

Kākāpō 125 was ultimately a very successful example of crowdfunded science. As the fundraising period neared its end, the shortfall in funding was met by Science Exchange. Science Exchange aims to 'democratize access to the world's scientific expertise' by brokering sales of scientific services (Iorns & Knox 2019). In this instance, the company arranged for the remaining Kākāpō genomes to be sequenced at Sydney's Kinghorn Centre for Clinical Genomics. A number of private donations plus some more creative fundraising supplemented the team's crowdfunding efforts. In exchange for a $600 donation, for example, donors could receive a piece of exclusive DNA art made from the sequence information of their preferred bird. This combined effort was ultimately so successful that the KRP could sequence all 125 birds, plus a number of newborn chicks and deceased specimens. Upon completing their data analysis in 2018, the group had sequenced 171 kākāpō genomes.

This achievement was also due to the KRP's ability to navigate various parties' interests. Although the premise of the Experiment.com model is that the resulting research will be made available to backers, Kākāpō 125 had its own conditions. As requested by Ngāi Tahu, data from the project is supplied on request to parties who demonstrate that they will use it strictly for non-profit purposes. Before the data is shared, a group of custodians must reach a consensus about the acceptability of its proposed use. The first sequenced reference genome, however, is openly available on data hosting platform github.

The KRP's efforts to sequence the kākāpō population saw scientists capitalise on the kākāpō's reputation to rally support for the sequencing from people around the world. From recruiting and retaining supporters to sharing project milestones, Experiment.com provided a vehicle for this work by wielding the internet's capacities for connection, information-sharing, and economic exchange. As scientists enrolled donors and followers, they themselves became part of a virtual community of fans and funders. As they take on the social labour of creating and sustaining a community, the job of the scientist changes, developing new accountabilities (to those following their work) and navigating existing ones anew (considering how to reconcile imperatives for openness with iwi sovereignty). However, in the context of public underfunding, the kākāpo project also highlighted the ongoing precarity of conservation science and its objects. Although the KRP's embrace of crowdfunding was seen as a way of creating opportunities and harnessing the charisma of kākāpo, the turn to crowdfunding also highlights the lack of institutional support for these conservation projects.

Iguaca

The story of the Puerto Rican parrot (*Amazona vitatta*, or iguaca) shares many similarities with that of its New Zealand cousin. In 1975, the iguaca population reached crisis point. Only thirteen individuals remained (US Fish and Wildlife Service 1990). As the only parrot endemic to Puerto Rico and the last remaining native parrot in United States territory, the iguaca became a focus of conservation efforts.

Before Columbus' arrival in the Americas, the Puerto Rican parrot may have numbered over 100,000 individuals, ranging across the Puerto Rican archipelago as well as nearby islands. Due to hunting, deforestation, hurricanes, and their popularity as pets, by the 1950s the population had decreased to just 200 individuals (US Fish and Wildlife Service 1990). In 1967, the iguaca was placed on the endangered species list, and in 1968 the US Fish and Wildlife Service, the US Forestry Service, and Puerto Rico's Department of Natural Resources initiated a conservation and management program (Herzog 1995).

Initially, these efforts focused on the wild population, providing nesting boxes designed to reduce predation (Christian et al. 1996). Following models established for other animals, the continued threat of eradication led to the establishment of a captive breeding program in 1973 (Barrow 2009; see also Braverman 2018). A hurricane-proof structure in the El Yunque rainforest was refitted with indoor flight cages for the parrots, and living quarters for biologists and veterinarians. Between 1973 and 1979, biologists collected eggs or chicks that had been abandoned or were unlikely to survive in the wild (Herzog 1995). Healthy chicks from the aviary were transplanted into wild nests to supplement the wild population. These efforts yielded some success: by 1989, the wild population had reached 47 birds with five breeding pairs. Despite these efforts, the iguaca remained critically endangered into the 1990s. In 1989, Hurricane Hugo devastated areas of the parrots' habitat, killing 50% of the wild population. The breeding program was also affected by low reproductive success, partly due to inbreeding (Brock and White 1992). The tiny population of parrots in the 1970s created a genetic bottleneck that necessitated continued genetic management: 'This involves a meticulous record-keeping system with capability of calculating demographics, pedigree charts, kinship values, etc.' (Herzog 1995, 273).

Genetic conservation

It was against this backdrop that efforts began to use modern genetic tools for iguaca management. In the early 1990s, biologists from Queen's University in Ontario used DNA fingerprinting to establish the genetic relatedness of the captive parrots (Brock and White 1992).[4] The use of genetics to aid iguaca conservation occurred at a time that both molecular methods were increasing in power and that the use of new tools, such as reproductive cloning, were being debated (Friese 2013). Such methods to the breeding program's success in the 1990s and 2000s: in 2011, one hundred parrots were born across wild and captive populations. Nevertheless, past inbreeding challenged ongoing efforts to re-establish parrot communities.

Taras Oleksyk, a population and evolutionary geneticist, believed that more genetic information would help the parrots' cause. Originally from the Ukraine, Oleksyk moved to Puerto Rico in 2009 from the US National Institutes of Health to establish a lab at the University of Puerto Rico – Mayagüez (UPRM). He suggested that sequencing the iguaca genome would contribute to managing the wild population and captive breeding programs, but also enable researchers to understand the evolutionary history of ancestral parrot species (Akst 2012). In 2011, Oleksyk began considering how to fund this effort. Genome sequencing was expensive. Even if someone could be persuaded to supply time on a sequencing machine, the reagents for sequencing one genome would cost about US$10,000 – a lot of money for a Puerto Rican university. Oleksyk summarized his problem on a slide: 'Strategy: Ask the University'; 'Drawbacks: University has no money (overhead goes to the government structure)'; 'Strategy: Write a research grant'; 'Drawbacks: It takes over a year to get the money and hard to justify for a place with no sequencing'; 'Strategy: ask a consortium: G10K'; 'Drawbacks: Interested in phylogenetically distributed sample, and another parrot (parakeet) is the best sequenced non-human genome.' (Oleksyk 2013).

Oleksyk did ask the G10K project based at the University of California Santa Cruz. Genome 10K aimed to study animal diversity and evolution by sequencing the genomes of 10,000 vertebrate species. The consortium's docket was full. Erich Jarvis, a neurobiologist from Duke University who led the avian arm of the project, told Oleksyk that they already had seventeen bird species to sequence and they could not get to the parrot until at least 2013 (Akst 2012). Oleksyk did not want to wait: 'I would like to do it now', he recalls thinking (Ibid).

Saving with style

Amazona vitatta is a beautiful, bright green bird measuring about one foot from head to tail (figure 2). It has long been a symbol of Puerto Rico and its diverse yet vulnerable fauna; the bird even appeared on a commemorative US quarter. Oleksyk realized he could use the birds' local fame to his advantage. He was particularly inspired by a painting of the parrot rendered by one of his graduate students' sisters. 'We could probably sell these and raise money for a sequencing project', he realized (Ibid).

Figure 2. Amazona vitatta.
Photo by Jose Almodovar.

This began a multi-year fundraising effort by Oleksyk and his students. A company called Axeq offered to do the initial sequencing for $2000. The UPRM team held an art show where they sold paintings and posters of the parrot. Much of the money raised came from UPRM students. ‘They brought their lunch money,’ Oleksyk (2016) said, ‘they donated $1 or $3 or $5’. The team raised just enough to fund the initial sequencing. Emboldened, they set out to raise more funds. They held more art shows and two fashion shows (called “Save the Parrot with Style”), plus a local fundraising campaign. Lab members went door-to-door inviting donations from local businesses, especially those they could use as door or raffle prizes at the shows. The team attempted to raise awareness of the parrot’s plight, and its significance for Puerto Rico. As one scientist told a local news outlet: ‘The parrot belongs to the people of Puerto Rico and it is up to the Puerto Ricans to save it, we hope that the genome will serve as an instrument to guide the work that is being carried out for the protection and conservation of the parrot’ (Vélez 2012).

The first fashion show was held in San Juan's Museo de Vida Silvestre (Wildlife Museum). Models stepped onto the runway through a giant plastic anthill and were greeted by stuffed representatives of global biodiversity: zebras, water buffalo, and gazelles (figure 3). The star of the show was Alexandra Wiscovitch, Miss Turismo Latino Puerto Rico 2012, and a former student of Oleksyk. Oleksyk's undergraduate genetics class inspired Wiscovitch to pursue a scientific career alongside modeling. Wiscovitch was pleased to see scientists, artists, and designers working together to create jewellery, clothing, and accessories for the event (Cabán-Hernandez 2014). Sponsors donated other clothing, largely in the reds, greens, and blues of *Amazona vitatta*.

Figure 3: Models walk the runway to raise money for iguaca genome sequencing.
Photo courtesy Taras Oleksyk.

Beyond these offline activities, the group made extensive use of social media. They set up the Puerto Rican Parrot Genome Project Facebook page (https://www.facebook.com/amazona.vittata/), created a Youtube video trailer to promote their fashion show (https://www.youtube.com/watch?v=1VwVfKBbqNo), and used Paypal to collect online donations. Later, the team used crowdfunding platforms such as GoFundMe to raise money. Between the shows and online donations, Oleksyk raised a further $8000. This money funded further sequencing that improved the coverage and assembly of the parrot genome.

The sequencing results were published in the online open-access journal *GigaScience* on September 28th, 2012. Alongside the scientific details (42.5 billion nucleotide bases sequenced at an average coverage of 27x; 76% of a 1.58 billion nucleotide sequence genome assembled), the article noted the remarkable circumstances of the work: 'The current data represents the first genomic information from and work carried out with a unique source of funding' (Oleksyk et al. 2012). Even the article title stressed the combination of knowledge and practical achievements in the project: 'A locally funded Puerto Rican parrot (*Amazona vitatta*) genome sequencing project increases avian data and advances young researcher education.' Oleksyk reported that the project was special because it involved undergraduates and young researchers as well as community members including artists, fashion designers, and activists. "We convinced our community that they could contribute to the development of local science, and our science can contribute to better understanding of the island's beloved species that needs help to come back from the brink of extinction" (Proffitt 2012). The parrot sequencing project engaged a broad community beyond the lab, and depended on “selling” the parrot in ways that allowed a wider public to participate in the project.

‘The People’s Parrot’

The global scientific press rapidly picked up the remarkable story. Bio-IT world dubbed *Amazona vititta* ‘the people’s parrot’ (Proffitt 2012) and the genome was featured on high-traffic sites, including *Genomeweb.com*, *Sciencedaily.com*, *Phys.org*, *Eurekalert.com* and others. Within days of the *GigaScience* announcement, the parrot appeared on news in Italy, Brazil, and France. By October 1st, 2012, the parrot genome project made the news in Puerto Rico, appearing in the *San Juan Daily Star*, *El Nuova Dia*, and other local outlets. The story was also well received on social media. According to the group’s Facebook page, posts associated with the *GigaScience* article had a daily reach of 12,456. On its first day, the parrot genome paper was accessed more times than any other in the journal. Many of these stories focused less on the scientific importance of the parrot genome sequence and more on *how* it had been done. The funding of the project ‘by the people’ caught attention. The media emphasized the parrot’s ability to captivate the public due to its ‘cultural relevance’ to the people of Puerto Rico. As *Ciencia Puerto Rico* reported, ‘the Puerto Rican parrot genome became a project of the people, by the people, and for the people’ (Díaz-Muñoz 2013). It was taken as an example of the ‘democratization of science’, and of genome sequencing specifically.

However, the story took on different meanings in different outlets. For libertarian news site *Reason.com* (2012), it demonstrated the success of ‘privatized genome research’ funded by individual donations. For *Genomeweb* (2012) the parrot was 'community-funded sequencing', whereas a *Scienceblog.com* (2012) headline stressed 'local funding'. For other sites, such as *NatureWorldNews*, the parrot genome was a conservation effort (Miller 2012). Like other viral media phenomena, the story reproduced rapidly, taking on significant variations in meaning across different local and global contexts. As the story migrated, the parrot genome occasionally flew out of the scientists' control.

Parrots of the Caribbean

The newfound (social) media fame created opportunities for Oleksyk and his team. He found himself speaking about the parrot genome at conferences around the globe. Oleksyk's success enabled him to raise further funds from private and public sources. By December 2012, the lab had received $20,000 from the Toyota Foundation and a further $20,000 from the US Fish and Wildlife Service in Puerto Rico (Akst 2012). These funds were spent on further characterizing Puerto Rican parrot's genome, including its transcriptome and genomic variation across individuals. Oleksyk also had his own University's attention. They supported the establishment of a Caribbean Genome Center at UPRM.

The parrot genome became tied to the open science and open data movements that were gaining momentum in 2012. The genome appeared, not by coincidence, in the first issue of the first 'data journal', *Gigascience*, and provided one of their first open access datasets. Not only was the data itself open, but the crowdfunding model that had generated the data fit the democratic ethos of open science. The provenance of the parrot data was important for what it suggested about where and how science could be done.

The parrot's success was also powered by the continued rise of social media and especially of Facebook. 2012 was the year of Facebook's IPO and the year that it reached one billion active users (Berkman 2012). Although the iguaca funding was largely a local phenomenon, it became a viral, global event. This internationalization drew wide attention and allowed the Puerto Rican scientists to gain financial support from their university, federal funding agencies and private foundations, as well as opening up a global pool of potential donors. In November 2012, the Caribbean Genome Centre purchased their own sequencing machine, an Ion Torrent. This would enable not only further sequencing projects, but also the training of local students in genomics and bioinformatics. 'Parrots of the Caribbean', as Oleksyk called his larger project, aimed to sequence the thirteen *Amazona* species that ranged across the Yucatan peninsula, the Caribbean islands, and into the northern jungles of mainland South America.

The Caribbean Genome Centre has since participated in numerous other genome sequencing projects, including that of the cheetah and the solenodon. Significantly, Oleksyk and colleagues have now successfully secured large federals grants for their research, suggesting the possible limits of the crowdfunding model in the longer term. However, the lab's work continued to be supplemented with crowdfunding, using campaigns on GoFundMe and Instrumentl.com. The participation of publics both within Puerto Rico and beyond were crucial to Oleksyk's success. He and his team undertook novel forms of scientific work both online and offline: creating art, performing fashion shows, and creating social media profiles. Through this labour they successfully mobilized the charisma and local significance of their parrot to create and sustain communities that engaged with (and funded) the parrot and its plight.

Discussion

Both kākāpō and iguaca conservation scientists made lifelines for their birds online. These projects suggest that alternative ways of doing science are emerging alongside traditional modes of science funding and practice. Considering the participatory dynamics of the kākāpō and iguaca projects, we suggest how the aesthetics, accountabilities, and geopolitical organisation of conservation science may shift asprojects are brought online.

Aesthetics

Opening up these projects through online fora increased their visibility, permitting non-experts to engage with and support specific research. It also makes those projects subject to appraisal by larger audiences, who may hold different value registers than those science has traditionally answered to (e.g. valorising objectivity, impassive enquiry, upheld by systems like peer review). Here, this increased visibility enabled researchers to assert their projects' worth by drawing on extra-scientific valuations such as national significance or cuteness. The value of these sequencing projects was not just the potential to know and protect the species – conservation science took on value as entertainment and 'content'. By embracing the popular aesthetic of internet animals, the researchers developed a shared language with diverse audiences and fostered two-way participation: inviting lay people to virtually participate in their projects required scientists to participate in internet culture.

In the participatory condition, doing science means appealing to new audiences, using new aesthetic practices. This manifests in both our examples: scientists make art, plan fashion shows, publish engaging social media content, and share videos. Their success derives partially from the parrots' charisma (Lorimer 2007), including their "rare" and exclusive status. Social media offer opportunities for scientists to construct stories through which publics can come to know and share their experiences with endangered species. The playfulness of both the kākāpō and iguaca projects conforms to the aesthetics of meme culture (Milner 2016) – the parrots generate value as cute and funny and therefore garner interest and support. Images and videos of parrots are curated in ways that encourage "multimodality, reappropriation, resonance, collectivism, and spread" (Milner 2016, 217). Thus, kākāpō appear on crowdfunding sites and BBC footage, but also as gifs, and in 75 hypercolored emoji for the messaging app Slack.

Here, gathering the resources to do genomic sequencing *requires* an aesthetic that makes people care about these birds enough to support them. It permits non-experts to engage with parrots through a value register that centres their rarity, charisma, or emotional resonance. Researchers funnel their parrots' charisma and charm through the visual lexicon of the internet, generating affect (awe, love, charm) that transmutes into tangible support. This aesthetic became an inalienable aspect of doing conservation science for kākāpō and iguaca. The same aesthetics that afforded support for the parrots may signal the limitation of crowdfunding in wider conservation science, however. A funding model that relies on visual appeal risks exacerbating a conservation landscape that already privileges charismatic species to the detriment of the less charismatic (Lorimer 2015). Moreover, the notoriously short life of memes suggests that support for particular scientific projects might evaporate quickly.

Accountability

Scientists also formulated new relationships with their online audiences. After Shapin's (2008) entrepreneurial scientist we may discover the social media scientist, engaged in both knowledge production and network-building, against a backdrop of increasingly competitive funding (c.f. Davenport & Bibby 2007; Goven 2006) and imperatives of public engagement. Although the participant is kept at arm's (or internet's) length, the scientist has a novel dependency on their 'audience'; it remains to be seen what would happen if that audience objected to researchers' decision-making. Atop the formalised checks and balances of traditional research, this accountability may operate in a more diffuse, subjectifying fashion as researchers adopt the pose of ever-responsive, outward-facing public scientists.

The accountability associated with the participatory condition demands near-constant attention. The immediacy of the digital world creates new temporalities for research. If the public finds that sharing was insufficiently frequent (or entertaining) attention (and money) could drift. Unlike traditional scientific funding models (where researchers capture reviewers' attention in a proposal and report results at the project's end) here attention must be actively *maintained*. This creates new and persistent obligations for scientists to be accountable by being ever-present. At the same time, "memetic media" (Milner 2016) escape control as content is repurposed and shared by unknown others (Wark and Wark 2019). This traffic of scientific objects and information exceeds the careful dissemination envisioned in earlier calls for engagement; to some extent, researchers relinquish control of the scientific narrative.

In participatory science ‘openness’ is also a mechanism of accountability. Openness is often treated as an unquestionable good, associated with sharing, equal access and benefit, and opposed to the enclosure of genomic data (e.g. through patenting (Parthasarathy 2017; Reardon et al 2016)). However, our examples highlight the ambivalences of openness. For example, the KRP acknowledged that as taonga (treasured) species, kākāpō and their DNA should not be ‘open’ to international companies or others seeking to profit from them. By vetting potential users of kākāpō data, the KRP refuse a blanket embrace of openness, proposing an alternative ethics that places openness in relation to Māori values. Just as participation implies but does not necessarily actualise equality (Bernard et al 2013), ideals of openness do not guarantee equitable use of open resources in contexts where differentially empowered actors coexist (c.f. Breem et al 2015, Hinterberger and Porter 2015, Sedyaningsih, Isfandari, Soendoro and Supari 2008). Indeed, openness brings with it additional responsibilities, like the expectations of attribution that Breem and colleagues (2015) describe in relation to grassroots mapping practice. It is also noteworthy here that participation via crowdfunding demands, relative to other forms of citizen science, only low levels of engagement on the part of the funders and the scientists. Participants are not asked to select problems to solve, to collect data, or to commit to the project over a significant period of time; scientists are not required to open their lab doors or to collaborate directly with the public (see Dosemagen and Parker 2019, Dosemagen and Gehrke 2017, Matz, Wylie and Kriesky 2017). While crowdfunded science creates scope for placing data in the public domain, the kākāpō invites us to critically consider how openness *changes* the accountabilities of science across cultural and geopolitical domains. It also draws to attention the closely circumscribed limits of openness and accountability in the crowdfunding model.

Furthermore, broader questions of accountability underlie the turn to crowdfunding, which becomes an expression of not just opportunity, but also critique. The scientists here turn to crowdfunding because government support and global research initiatives have not delivered the resources they require to their jobs, or at least the new ways they wish to do their jobs (conservation through genomic sequencing). Researchers thus frame their crowdfunding as borne of necessity and as a critical response to political neglect.

Geography

Our cases also indicate changing geopolitical dynamics in science. This manifests starkly in the iguaca project, which articulated a struggle between established centres of science and science funding (the U.S.) and more marginalized universities and projects. The iguaca sequencing became an almost anti-colonial struggle to establish Puerto Rico (and the UPRM) as a place where high-quality science could be performed. Contributing to the parrot genome became a symbolic and tangible statement: funding its sequencing became an act that symbolized the redistribution of scientific power away from the centre and towards the periphery. If historically EuroAmerican nation-states have assumed the mantle of knowledge production and cast the Global South as the home of culture and belief (Harding 2015), here Puerto Rican and New Zealand researchers speak back to the scientific centre through their research. Researchers in other peripheral locations have not always been able to assert their priorities in the global scientific landscape (Shrum 2005, Rodriguez-Medina et al 2019), but the iguaca and kākāpo teams managed to define their research problem, attract support and funding, and issue findings and updates to a globally distributed audience. The durability of such shifted relations remains to be seen.

These narratives show how online platforms can generate new and unexpected networks of engagement with science. Social media and sites such as *Gigascience* and Experiment.com allowed Puerto Rican researchers to mobilise local support to both claim iguaca as a species of scientific importance, and stake their claim as the best scientists to sequence it. Likewise, support for kākāpo came from many individuals living far from New Zealand, who were nonetheless captivated by the parrot's distinctly local story. Local and national scales remain important, even as potential publics become more global. Rather than unmooring science from its localities, crowdfunding and social media brought together differently emplaced people and scientific projects. While these new relationships favoured kākāpo and iguaca in this instance, it is less clear how such dynamics may play out in the future. The support of local and international online audiences freed researchers from the constraints of public funding, but the long-term viability of crowdfunding research remains improbable. A reallocation of dependencies – from government, onto North American-based web platforms – may portend the emergence of similarly compromising relations between scientists and their funders.

Conclusion

The boundaries between scientific and public spheres are continually reworked as scientists, policy-makers, and citizens negotiate the role of science in society. As science funding changes and demands for engagement increase, some practitioners seek recourse to newer technological conjunctions. Offering new communicative affordances, the internet has *the potential* to alter how and for whom science is practiced – but is not an automatically democratising nor value-neutral force (Hine 2002, Hilgartner 2012). In conservation science, crowdfunding and social media interpellate genomic data into new relations between scientists and citizens. With these technologies, scientists and publics at least momentarily reshape the organisation and ethos of scientific practice, as well as the scientist as subject.

The uptake of crowdfunding and social media changed both the social landscape and scientific practice of conservation for two endangered parrot species. Taking kākāpō and iguaca online invited new aesthetic possibilities, as visual and narrative parrot 'content' joined the pop culture miscellanea of the internet. By building a community of followers and funders, researchers also reconstructed relations between parrots, publics, and the scientific community, making their work legible through alternative value systems. It is not only lay persons partaking in science anew here – researchers themselves participate in social worlds beyond their research locale. Furthermore, by connecting researchers in Aotearoa and Puerto Rico with followers around the world, these crowdfunding efforts hint at a geopolitical reorganisation of science. When American genome scientists wouldn't sequence the iguaca, internet connectivity enabled that work to be done in and by the parrot's home country. We read these changes in the context of the 'participatory condition' (Barney et al, 2016), which denotes a move towards active involvement as a moral hallmark of contemporary social life. The ‘participatory condition’ has become an epistemic category as well as a moral one.

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[1] Aotearoa is the Māori name for the place known as New Zealand.

[2] A1 conducted pilot research on conservation genetics for Aotearoa's native birds in 2018.

[3] Iwi is a Māori word denoting a group of shared ancestry, often identifying with a particular area.

[4] DNA fingerprinting is a method for establishing the genetic features of individuals (as opposed to whole species).