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Why is single-use plastic still in the conservation sector toolbox?

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ABSTRACT
Microplastic residue left in the environment from plastic chewcards in three pest mammal monitoring operations was estimated at an average of 15% of the starting weight. This finding highlight the issue of single-use plastics within New Zealand's (NZ) conservation sector. A review of other research operations across NZ shows a significant number of plastic chewcards are deployed, potentially contributing to microplastic pollution in environmentally sensitive areas. Our research shows the need for sustainable alternatives to plastic chewcards in order to mitigate the environmental impact. Alongside an estimation of microplastic being left in the environment, we evaluated wood-pulp chewcards as a potential alternative to corflute chewcards, with results indicating wood-pulp cards maintain comparable interaction rates across key pest species. By identifying the environmental issues of microplastics in the environment and offering a potential alternative, we aim to open a dialogue about adopting more sustainable tools and practices in the NZ conservation sector.

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Introduction

Within the conservation sector, there is a lack of documented research quantifying the use of single-use plastic and its potential environmental impacts. While other sectors have reduced their reliance on plastic, especially single-use plastic, the conservation sector has not actively emphasised plastic minimisation. We highlight the importance of the New Zealand (NZ) conservation sector joining the efforts of other sectors, to minimise plastic waste entering landfills and dispersing as microplastics into environmentally sensitive environments. We undertook a pilot study to determine the potential amount of microplastic residue left to disperse into the environment, and to investigate a potential, sustainable alternative.

Plastic use in New Zealand

The significant increase in plastic usage in NZ in recent decades has led to a high accumulation of plastic waste and pollution, presenting substantial environmental

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challenges. Despite its small size, NZ generates a disproportionately high daily plastic waste per capita, compared to other nations (The Royal Society of New Zealand 2019). The majority of plastic is discarded into landfills, where it is crushed and buried, slowly degrading into smaller pieces of micro and nanoplastic (Mora-Teddy and Matthaei 2020). The degraded plastic is likely to persist indefinitely, with nanoplastics representing the smallest known particle size, although it is suggested that even smaller particle sizes exist (Conkle et al. 2018).

While the effects of plastic waste and pollution are still being identified, many countries including NZ, are attempting to reduce their reliance on plastic. NZ's hospitality and retail sectors are at the forefront of the plastic ban, with reusable bags, coffee cups and cutlery becoming the norm. The building sector is moving to encompass more sustainable practices, while many landscaping businesses are moving to biodegradable alternatives (Baker 2022). The emphasis on incorporating sustainable alternatives into business operations has been notable in many sectors, but the conservation sector is not one of them.

Single-use plastic in the New Zealand conservation sector

Addressing the conservation impact of introduced pest mammals has meant monitoring, control and management tools have been compiled into a conservation sector 'toolkit'. The most common mammalian pests monitoring tools used in NZ–chewcards and waxtags–are made of plastic and primarily engineered to be single-use. Despite the need to address the threat posed by introduced pest mammals, the use of single-use plastic monitoring tools highlights a critical gap in sustainable practices within the conservation sector. There is a need to reassess and be innovative with the tools and methods used in conservation operations to align more closely with the ethos of environmental stewardship and sustainability. The reliance on these single-use plastic tools in the NZ conservation sector highlights the broader trend in several industries where convenient short-term solutions often take precedence over long-term environmental considerations.

To reduce the conservation sectors' reliance on single-use plastic, several aspects of the problem need to be addressed. First, the issues associated with plastic, including environmental damage and health risks, must be highlighted. Second, viable and environmentally friendly alternatives need to be showcased. These alternatives must be as effective as current industry standards and cause minimal negative environmental impact. Third, there must be a clear demonstration of the financial viability of adopting these alternatives, ensuring they are economically feasible and sustainable for organisations and businesses around NZ. Finally, garnering support from stakeholders in the NZ conservation sector for the need for change is crucial for the success of plastic-free alternatives.

Waxtags and chewcards

Plastic chewcards were introduced into the conservation and pest control industry in the early 2000s (Sweetapple and Nugent 2011). Chewcards are interference devices that are left in the field for a specific period. They identify the species of mammals that may be present in an area by collecting tooth mark impressions. The proportions of devices bitten by particular species provides an index of species relative abundance within the monitoring area (Kavermann 2013). Plastic chewcards consist of white twin-walled corflute (polypropylene) sheets with internal channels aligned parallel to the 90 mm sides. Attractant bait (peanut butter, aniseed, Nutella) is pressed into the internal channels; and the cards are then attached to tree trunks, stakes or fence posts using a nail or staple gun (Figure 1). Many characteristics of corflute are beneficial for the pest control industry as they are light in weight, inexpensive, easily transported in large volumes and widely available. The utility of chewcards in monitoring mammalian pest species is well understood (Sweetapple and Nugent 2011), and there is a standard protocol for their use (National Pest Control Agencies 2015).

Waxtags were introduced into the conservation industry in the 2000s and a standard protocol was created in 2006 (updated in 2015 (National Pest Control Agencies 2015)). Waxtags (N.Z. patent 516900, Pest Control Research, Christchurch, New Zealand) are designed to detect the presence of animals that bite and leave marks on a wax block. The device consists of a pyramid-shaped 12 cc block of microcrystalline wax. 2 × 2.5 cm at its base and 2.5 cm high, moulded onto the acute end of a triangular plastic tag that is 6 cm wide and 12 cm tall (Sakata 2011)

Waxtags and chewcards were introduced at a time when leg-hold traps were one of the most common tools for possum (*Trichosurus vulpecula*) monitoring and tracking tunnels were most common for rodents (*Rattus* spp, *mus musculus*.), and mustelids (*Mustela* spp.). These new tools were considered a substantial improvement on older methods as they offered a humane, non-invasive, cost-effective alternative that demanded significantly less labour (Forsyth et al. 2018). However, both methods pose sustainability challenges.

Waxtags and chewcards are designed to be single-use and made of polypropylene plastic. After they are utilised they are discarded in landfills. The standard protocol encourages the removal of all equipment from the field however unforeseen accidents can occur, resulting in the accidental introduction of plastic into areas of high conservation priority that would typically be free of plastic contamination. Unlike organic materials, polypropylene does not break down, contributing to long-lasting plastic

Figure 1. Plastic chewcard baited with peanut butter. Photo source: Landcare Research.

pollution (Karger-Kocsis and Bárány 2019). Microcrystalline wax, similar to other waxes such as paraffin and beeswax is reportedly biodegradable (Matsumoto et al. 2017). However, the polypropylene plastic tag component of waxtags is not biodegradable, thus adding to plastic pollution when discarded as it slowly degrades to microplastic over time.

Chewcards generate microplastic as animals chew on the cards and leave behind small fragments (Figure 2), including <5mm-sized microplastics. Plastic chewcards attract pest mammals such as rodents, possums and hedgehogs. When these mammals bite into the bait applied to the inner channels of the card, they leave distinctive bite marks; however, the act of biting often results in the deposition of microplastics beneath the card. The amount of microplastic likely varies depending on the biting mechanisms of the different pest species. Chewcards are often heavily damaged in areas with high rodent abundance (James Ross–Lincoln University, personal communication). Rodents typically leave a ragged or gnawed profile edge, which may lead to high levels of microplastic being deposited. In regions with high rodent abundance, the chewcard will often have significant damage to the card margins with a greater amount of plastic fragments left on the ground. If possum abundance is high, cards will likely have crushed margins and large fragments ripped off and left at the site (personal observation). If enthusiastic enough, the whole card may be removed from the tree and lost in the understory. These large fragments are considered mesoplastics as defined by their size (0.5–5 mm); however, due to physical abrasion and UV, they will most likely transform into microplastic if left in the environment. If hedgehog biting is extensive, the blunt incisors can crush the card margins like possums. However, it is most common to see ‘pin prick’ bite marks from hedgehogs (Sweetapple and Nugent 2017)It is also likely that chewcard microplastic dispersal may be further than first identified as both rodents and possums often consume

Figure 2. Chewcard and associated microplastic residue. Photo source: Katie Pitt.

the corflute material, resulting in the plastic ending up in their faeces which will then be scattered further afield (Craig Morley–Toi Ohomai Institute of Technology, personal email communication).

Estimating the percentage of microplastic left in the environment by individual plastic chewcards

The extent to which chewcards contribute to microplastic pollution in NZ remains undocumented. A search conducted on Google Scholar, Scopus and Web of Science using the keywords 'single-use plastic' and 'New Zealand conservation' yielded no references regarding the use of single-use plastic in the conservation sector. The first step in addressing this issue is establishing a baseline of the amount of plastic used in the NZ conservation sector. We then need to identify the potential plastic residue left in the environment that may contribute to microplastic pollution. Therefore, we conducted field trials at three locations across NZ to assess the potential presence of microplastics left by plastic chewcards.

Methods

A grid method was used to determine the percentage of microplastic left in the environment from individual plastic chewcards. For this trial, all corflute chewcards were 10 cm x 10 cm. Once chewcards were collected, they were placed onto a 10 cm x 10 cm grid that is made up of 100, 10 mm x 10 mm squares, and the number of squares remaining visible was counted (Figure 3). The number of visible will correlate with the percentage of plastic left in the environment.

Once the percentage of plastic missing was calculated, it was used to determine how much plastic (in grams) was left in the environment after each operation. Each square on the grid equals 1 cm and which corresponds to 0.05 grams of plastic missing from the chew card.. If two squares of plastic are missing, 2% or 0.1 g of the plastic has been left in the environment; if 20 squares are missing, 20% or 1 g of the card has been left in the environment.

Each partial square with any plastic missing was counted as an entire square. This method was chosen due to the small weight of the chewcards. As the weight is so small, typical food scales lack the precision needed to accurately measure the small changes in weight. Additionally, the amount of peanut butter used as baits on the chewcards can vary slightly, which may introduce another variable to weight measurement. Using the grid method, we ensure consistency in measuring the percentage of plastic missing, as each square on the grid represents a uniform area. Even if a square is only partially missing plastic, counting it as a whole square provides a standardised way to estimate microplastic residue.

Field sites

Trials were completed at three sites, each site with a different prominent habitat. Taranaki trials were conducted in dense native podocarp that is heavily managed

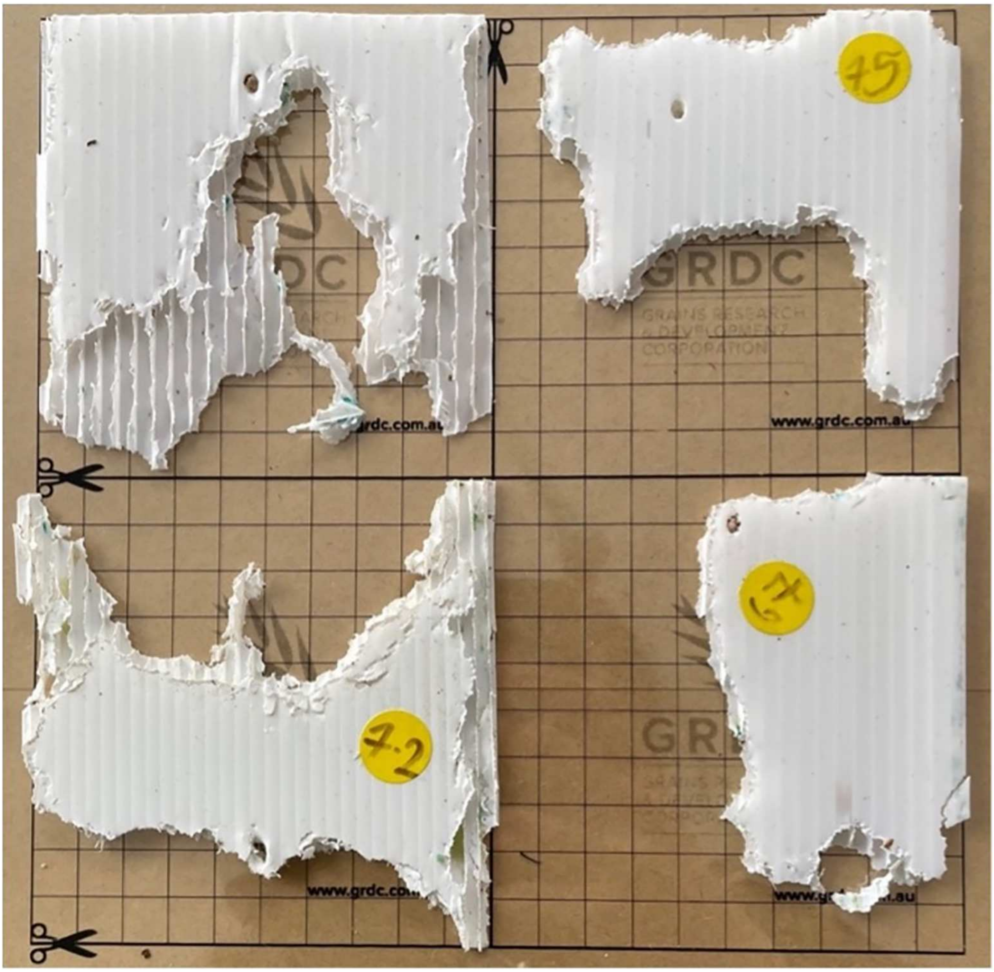

Figure 3. Grid printed on OHP paper used to measure plastic residue. Photo source: Katie Pitt.

for pest mammals year-round. Tai Tapu consisted of a pine plantation, while the Windwhistle sites consisted of exotic mixed farmland, characterised by agricultural land that is a mix of exotic plant and tree species and pasture. These latter sites had no prior pest management. Trials conducted in Windwhistle and Tai Tapu lasted one night each due to unknown pest mammal populations. In contrast, the Taranaki trial was extended over two nights, with chewcards being replaced nightly, as the pest mammal population was known to be high (Taranaki Regional Council 2019).

During each field trial, 20 cards were placed at each trial site on either two 200 m lines or one 400 m line, depending on the landscape. Suitable chew card sites along the lines, were chosen based on their availability. Three relatively adjacent trees held the chewcards and trail cameras, with each site a minimum of 20 m away from the previous site as per the Department of Conservation (2021) standards, in a randomised position (left or right of the transect) to minimise bias.

Table 1. Number of plastic chewcards, total weight of plastic deployed, weight and percentage of plastic consumed and habitat for Taranaki (night one and night two), Tai Tapu and Windwhistle trial sites.

Trial	Number of plastic chewcards	Total plastic deployed (g)	Plastic missing/ consumed (g)	% of plastic missing	Habitat
Taranaki (Night 1)	20	100	9.41	9.41	Dense Native Forest
Taranaki (Night 2)	20	100	25.25	25.25	Dense Native Forest
Tai Tapu	20	100	11.2	11.20	Pine Forest
Windwhistle	20	100	15.3	15.30	Farmland
			Total = 61.16	Average–15.29	

Results

In Taranaki, 40 chewcards weighing a total of 200 g were deployed over two nights (2-night trial–20 new cards deployed each night). Night one showed 9.41% of plastic being left as plastic residue while night two saw 25.25% plastic residue, which gives an average of 17.30%. In Tai Tapu and Windwhistle, 20 chewcards each were deployed over one night, totalling 100 g each, with 11.20% and 15.30% respectively remaining as microplastic (Table 1). Combining these results, the mean percentage of microplastic left in the environment was 15.29% (+/- 3.08% SE).

The data collected showed considerable variation in plastic consumption among individual cards at the different sites. The median consumption is around 1 g of plastic, with most sites showing consumption between 0.5 and 1 g. However, there were outliers values, with some sites having cards exceeding 3 g of plastic consumption, suggesting that certain locations have significantly higher levels of plastic interaction. This variability highlights the potential for more plastic residue to be left at individual sites.

Preliminary conclusions

The above data highlights the potential environmental impact of single-use plastic used in conservation, in this case by the use of chewcards. Despite their efficacy in monitoring introduced pest mammals, the potential for microplastic pollution cannot be overlooked. The findings of this trial reveal that even with a very conservative estimate (1-2 nights) of 15% of deployed plastic persisting as microplastic litter, substantial amounts could accumulate over time, especially in areas with high rodent abundance. This highlights a major problem in the current conservation practices, where the introduction of plastic to vulnerable habitats overrides the overarching goal of ecosystem preservation.

Discussion

These trials indicate that a consistent proportion of plastic residue was left in the environment across a range of habitats. The average percentage of microplastic residue remaining after our trials was 15.29%, with slight variations across sites. These findings suggest that there could potentially be an accumulation of microplastic in the environment especially in areas with high rodent abundance, which poses a potential long-term threat to ecosystem health.

Current best practice suggests leaving chewcards in the field for three or seven nights, positioned 20 m apart along 200 m lines (National Pest Control Agencies 2015). If pest mammal density is low, chewcards will be left out for seven nights as per the NPCA (2015) low-density protocol. In areas with higher pest density the NPCA (2015) suggests leaving chewcards out for at least three nights. Despite these recommendations, many operations deviate from the 2015 protocol due to time and resource availability. Based on conservations with field practitioners, the actual duration of many monitoring operations is a combination of available resources, such as finances and labour, and the pest mammal density in the area. In areas with high pest mammal populations, deploying the chewcard for more than one night may result in saturation of the cards (Burge et al. 2017), evident in areas with high rodent populations specifically (James Ross, personal communication). This variation in use is evidenced by looking at chewcard usage in several research projects. Most field researchers leave chewcards out for at least three nights and often up to seven nights. Some research trials leave the cards out for considerably longer (Table 2).

The three field trials we measured were very small compared to other larger conservation and research operations regularly done across NZ. IF we assume that a mean of 15% of deployed plastic might remain as microplastic litter after one night. We can now examine the potential amount of plastic left in other operations. Chewcards weigh approximately 5 g (100 mm x 100 mm cards), and with approximately 96,000 chewcards were purchased in the last 12 months from a single supplier (Victoria Davies–Connovation Ltd, personal email communication) this implies that 480 kg of corflute plastic could potentially be deployed annually. If we assume typical consumption rates, 72 kg out of the 480 kg deployed could be left as microplastic litter with the remaining 408 kg of used chewcards sent to landfill.

There was a varying range of chewcards usage in five NZ research trials that we reviewed (Table 2). In the Kaitake Ranges (Sweetapple and Nugent 2011), 1826 plastic chewcards were used during a two-week research monitoring operation (Sjoberg 2020). This operation could have led to 9 kg of plastic being placed into the environment, with approximately 1.3 kg (assuming typical rates of consumption) of microplastic litter remaining at the project completion. During several other research trials, including trials in NZ's Auckland region and Waitakere, NZ, 90 mm x 180 mm chewcards were used, increasing the weight of the chewcard and the amount of plastic being deployed. During much larger operations, such as the one conducted on the West Coast of NZ,

Table 2. . Number of plastic chewcards, chewcard weight, total plastic and average waste (grams) and operation duration for larger pest mammal operations in New Zealand.

Trial	Number of plastic chewcards	Chewcard weight (g)	Total plastic (kg)	15% average waste (g)	Operation duration
Kaitake Ranges, NZ	1826	5	9.13	1369.5	21 nights
Awarua Wetland, NZ	156	5	1.30	278	5 nights
Auckland Regions, NZ	652	10	6.52	978	3 nights
Waitakere, NZ	154	5	0.77	115.5	3 nights
West Coast, NZ	1536	5	7.68	1152	155 days
Hauhungaroa Range, NZ	5363	10	53.63	8044	130 nights

the number of chewcards deployed over two years was 1536. However, owing to incomplete data, this figure represents the minimum number of cards used, with the potential maximum being 3072 (Nugent et al. 2019). In another trial, 5363 chewcards were used over a three-year period in the Hauhungaroa Range, NZ (Sweetapple and Nugent 2020), further supporting the high amount of plastic being deployed in the environment.

Although the quantity of microplastics left in the environment may appear insignificant on an individual site basis, the cumulative nature of plastic in areas of high conservation priority is the primary concern. Considering the ever-increasing number of annual monitoring operations across NZ, the combined amount of microplastic entering our ecosystems could be higher than initially expected. The broader issue lies in the absence of proactive measures to mitigate our plastic usage. As a sector aiming to preserve, protect and restore our natural ecosystems, introducing single-use plastic seems counterintuitive.

Wood-pulp chewcards–a potential alternative?

Wood-pulp chewcards, also referred to as 'bio' chewcards are created from recycled wood pulp, offering an environmentally friendly alternative to conventional plastic chewcards. The wood pulp originates from responsibly managed forests, certified by the Forest Stewardship Council, guaranteeing sustainable harvesting practices and consideration for environmental impacts throughout the supply chain (KATZ 2023).

Wood-pulp chewcards, like plastic chewcards, are baited with peanut butter. Peanut butter oil does not appear to affect the integrity of the material. During all trials using wood-pulp chewcards, there were no instances of the cards becoming soft, losing their shape or becoming less rigid due to the infused oil. High rainfall levels do not appear to affect the rigidity or shape of the cards. In a trial conducted on Mount Taranaki with a monthly average of 1460.5 mm (Taranaki Regional Council 2023), the cards maintained their rigidity and shape, with rain falling nightly over the two-night trial. Following the completion of the trial, these wood-pulp chewcards were securely stored in plastic zip-lock bags for one week until the identification of bite marks. No change in the integrity of the material was observed after this storage period.

The cost of plastic chewcards ranges from $0.40 (unfilled) to $0.50 (filled with peanut butter or aniseed). Wood-pulp chewcards are made of a repurposed material that is currently used in marketing and outdoor displays both in NZ and globally. The material used for this research was sourced from CQ Print and comes in large sheets. By purchasing in bulk and cutting the cards to size individually, each card costs approximately $0.35, while opting for pre-cut cards increases the price to $0.80 each. These prices are sourced from a single supplier; however, conducting further research on other suppliers and expanding contacts may offer cheaper alternatives. Additionally, if wood-pulp chewcards gain market traction, wholesale prices of the material could likely be negotiated, further reducing the individual price of wood-pulp chewcards.

Social survey

To gather opinions on using single-use plastic monitoring tools and the potential integration of a sustainable, plastic-free alternative (see manufacturing details below), we sent our estimation of microplastic results, with a survey, to key stakeholders in the NZ conservation sector. Thirty-seven individuals from 30 organisations responded to the survey, with 97.1% agreeing that single-use plastic was an issue for them and that they currently use a significant amount of single-use monitoring equipment. The majority, 97.2%, agreed they would use sustainable alternatives to chewcards and other eco-friendly monitoring tools, if they were comparable to traditional tools.

The survey highlighted several common requirements that individuals in the conservation sector would need before accepting sustainable, eco-friendly tools into their operations. These included ensuring that any new product caused no environmental harm if left in the field. Additionally, the new tool needs to be as accurate, cost-effective, accessible to all types of groups and organisations and as attractive as the current industry standards. To successfully develop pest mammal monitoring tools that are environmentally friendly, each tool must show comparable reliability and information to the current plastic option.

Given positive stakeholder interest in sustainable, eco-friendly alternatives to chewcards from individuals and organisations across NZ, we have been undertaking trials on wood-pulp chewcards. Statistical analysis suggests that wood-pulp chewcards have higher interaction rates than plastic chewcards. In studies conducted at the same sites detailed above and a trial conducted by a Lincoln University student in Boyle River, Canterbury, possums, rodents and hedgehogs showed a higher probability of interacting with the wood-pulp chewcard compared to plastic chewcard. The overall probability of

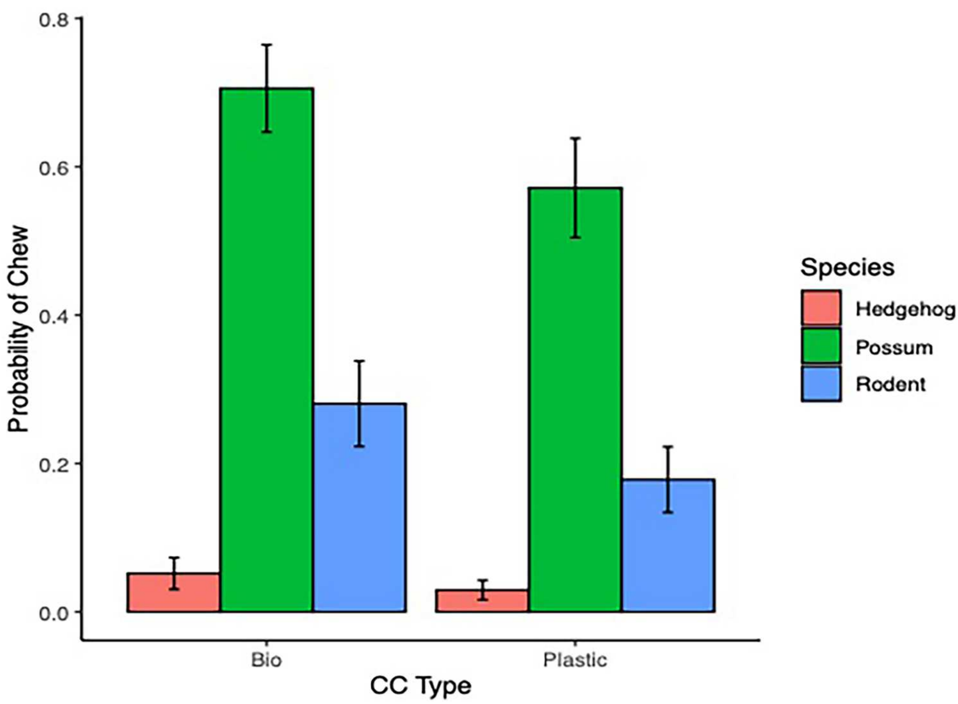

Figure 4. Interaction rates of key species–hedgehog (red), possums (green) and rodents (blue)–towards wood-pulp (bio) chewcards and plastic chewcards.

interaction with wood-pulp chewcards was 27.1% (SE = 4.6%). In contrast, the probability of interaction with plastic chewcards was 17.1% (SE = 3.6%). The difference in interaction rates was statistically significant, with a p-value of 0.004 and there was a significant difference between species (Figure 4). Combined chewcard indices (CCI) from all four trials also corroborate these results, with plastic chewcards having a chewcard index of 77.4%, while biodegradable chewcards had a CCI of 85%. These results suggests that wood-pulp chewcards may be as effective at attracting pest mammals in NZ as corflute chewcards. It is expected that bite marks will remain clear and distinctive on wood-pulp chew cards even if field conditions are wet. Future trials will aim to evaluate this.

Conclusion

In summary, the extensive use of single-use plastic monitoring tools in the NZ conservation sector poses sustainability challenges, particularly regarding the generation of microplastic pollution in sensitive ecosystems. While tools such as chewcards and waxtags have proved effective in monitoring pest mammal populations, their plastic composition contributes to long-lasting environmental pollution.

The introduction of wood-pulp chewcards could offer a promising, innovative alternative, offering comparable reliability to plastic chewcards while also reducing environmental harm.

Our initial research trials suggest that wood-pulp chewcards perform as effectively as plastic chewcards in attracting pest mammal species and identifying bite marks of rats and mice possums and hedgehogs, with the added advantage of being recyclable and biodegradable. While further research must be done to fully assess the true effectiveness of wood pulp chewcards, transitioning towards sustainable alternatives aligns with conservation goals, reducing the negative environmental impacts associated with single-use plastic while maintaining effective and accurate monitoring practices.

There is an opportunity here for the NZ conservation industry to display leadership in reducing plastic pollution and the damaging environmental effects it has. Plastic will inevitably end up in our environment. Bait stations, traps, trail cameras, warning signs and track markers are all plastic tools used in NZ pest mammal monitoring and control. A distinguishing feature, however, is that these tools are engineered for multiple uses to reduce waste and environmental impact. We wish to draw attention to and encourage discussion about the reliance on single-use plastic in NZ's conservation sector and the need for proactive measures to reduce it. By identifying the environmental issues of plastic in our environment, this research aims to open a dialogue about the potential development and adoption of sustainable alternatives.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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