REVIEW

Environmental impacts of tobacco product waste: International and Australian policy responses

Lucinda A. Wallbank, Ross MacKenzie , Paul J. Beggs

Received: 26 August 2016 / Revised: 27 October 2016 / Accepted: 31 October 2016 / Published online: 14 November 2016

Abstract The health risks of tobacco consumption are well established, but there is less awareness of the global environmental impacts of smoking. The by-products of the 6.3 trillion cigarettes smoked annually are filters (butts) that contain benzene, nicotine, cadmium, and dozens of other chemicals. It is estimated that between one- and two-thirds of all filters are discarded on roads, pavements, and green spaces. Butt litter as an environmental and public health hazard is a relatively new field of study, but recent research and findings have clear global implications. While this article focuses specifically on the situation in Australia, where cigarette butts are consistently the most littered item identified in national clean-up campaigns, the material reviewed has clear international environmental implications. The article first reviews existing literature on filter composition and toxicology, clean-up costs, regulatory response, and key policy actors. It then describes the scale of the butt litter problem in Australia using existing data, and analyses potential remedies at both the domestic and international levels.

Keywords Cigarette butt litter · Environmental organisations · Policy response · Tobacco industry · Toxicology

INTRODUCTION

The health risks of tobacco consumption are well established. It kills an estimated 6 million people every year, a figure that will rise to 8 million by 2030, and will result in more than one billion deaths this century (Mathers and Loncar 2006; Jha 2009).

There is markedly less awareness of the environmental impacts of smoking, and research in this area has been

largely focused on second-hand smoke exposure, responsible for an estimated 600 000 deaths among non-smokers (Öberg et al. 2010). More broadly, there has been limited research into the environmental implications of the cigarette lifecycle: cultivation and curing, production, consumption, and post-consumption disposal (Novotny et al. 2015). Increasing concerns regarding deforestation, use of pesticides and chemical fertilisers, the impacts of cigarette manufacturing and distribution, and disposal of tobacco product waste, however, have led to a growing interest among researchers whose work has clear international implications.

Tobacco product waste has until recently received the least attention, yet post-consumption rubbish produced by the approximately 6.3 *trillion* cigarettes smoked globally every year includes some 300 billion cigarette packs that produce an estimated 1 800 000 tonnes of waste paper, cellophane, foil and glue; and trillions of cigarette butts that are littered on roadways, pavements, and in parks and other green spaces (Novotny et al. 2009, 2015).

Discussion of potential environmental impacts of discarded cigarette butts has, in some cases, met with scepticism or simple reductionism that focuses too narrowly on a single aspect of current research (Chapman 2016). The reality, however, is that of the roughly 6 trillion cigarettes consumed annually, 75% of butts (4.5 trillion) are littered, equating to between 750 000 000 and one billion kilograms of non-biodegradable, cellulose acetate filters that are infused with benzene, nicotine, cadmium, and dozens of other chemicals drawn from the cigarette (Proctor 2012; Novotny and Slaughter 2014).

Why smokers litter is an ongoing question for government, environmental non-government organisations (NGOs), and cigarette manufacturers in all countries. Surveys of United States (US) smokers in 2012 found that

74.1% had discarded cigarette butts at least once, and over half admitted to dropping them on the ground, or down a sewer or drain within the previous month (Rath et al. 2012). These findings are in line with data from the United Kingdom and other US studies (Rath et al. 2012), but the rationale for this behaviour is less clear. Cigarette butts are more likely to be littered than most other items due, most obviously, to personal burn risk, but also because smokers do not know what else to do with them, and to a distinction made by smokers between perceived acceptability of littering butts compared with other rubbish (Smith and Novotny 2011). Tobacco industry analysis of smokers' attitudes revealed that smokers disliked cigarette butts whether in ashtrays or discarded, and were unenthusiastic about eco-friendly cigarettes, anti-litter campaigns, and portable or permanent ashtrays, leading industry analysts to the conclusion that the "complex psychology of butt littering made difficult identifying any message that might change the behaviour" (Smith and Novotny 2011).

Discarded cigarette butts, until recently perceived primarily as an aesthetic concern, have been recently reframed as an economic and environmental issue (Novotny and Zhao 1999; Novotny et al. 2009). Recent related research has included analysis of filter composition, toxicology, and leachates; related costs of clean-up in urban settings, and of fires; as well as potential regulatory response and the strategies of key policy actors. While most research to date has been carried out in the US, much of it in California, discourse around related environmental impacts has relevance for all countries, reflected in an increasing awareness among parties to the World Health Organization's (WHO) Framework Convention on Tobacco Control (FCTC) (Javadian et al. 2015).

For Australian researchers, concerns regarding ocean and coastline ecology, significant forest fire threat, cost of clean-up, and the role of policy actors in discussions around responsibility for the issue of cigarette butt disposal raised in research conducted in California is clearly relevant. While the smoking rate among Australian adults has dropped to a historic low of 14.7% (Australian Bureau of Statistics 2015), the approximately 2.6 million remaining smokers consume some 20 billion cigarettes per year and discard some 7 billion butts into the environment (Scollo and Winstanley 2015), which has consistently made them the most littered item in the country over the past fifteen years (Clean Up Australia 2015).

This paper argues that the potential impacts of discarded cigarette butts in Australia have yet to be adequately assessed, and that related research conducted elsewhere provides useful guidelines. It first highlights the key issues through a review of the literature on related environmental and economic costs, regulatory proposals and key actors, and assesses existing research and data sources relevant to

analysis of the situation in Australia. It then analyses potential legal and policy options that may provide direction for future response to the environmental impacts of butt litter, both in Australia and internationally.

DISCUSSION

Health claims, environmental impacts, and policy

Cigarette filters are a mid-twentieth century innovation, originally created to keep loose tobacco out of smokers' mouths (Smith and Novotny 2011). In 1950, less than 1% of cigarettes sold in the US were filtered, but subsequent publication of epidemiological studies that linked smoking to lung cancer led the tobacco industry to rethink cigarette design and to add filters (Warner 2002). Associated promotion focused on the capacity of filters to capture dangerous components of inhaled smoke without compromising flavour, and led to an enormous shift in smoking behaviour. Overwhelmingly positive public response meant that by 1960, 51% of all cigarettes sold in the US were filtered, rising to 99% by 2005 (United States Department of Health and Human Services 2010).

However successfully tobacco companies have convinced consumers that they are now protected from dangerous chemicals in cigarettes, filters have no health benefits. Early results obtained from machine-based testing suggested reduced tar and nicotine inhalation, but mechanical measurement differs markedly from how smokers consume cigarettes. Ventilation holes in filters allow smoke to escape before entering testing machines, but these holes are covered by smokers' fingers, and it has also been demonstrated that smokers inhale more deeply to compensate for filtration (Kozlowski and O'Connor 2002).

Filters are not only a health deception perpetrated by the tobacco industry, they have been associated with *increased* risk, given that the misplaced sense of security associated with smoking filtered cigarettes has almost certainly reduced health concerns, resulting in increased smoker initiation, and postponed quit attempts (Stratton et al. 2001; Warner 2002). Filtered cigarettes also produce elevated levels of more-addictive free-base nicotine, and deeper inhalation by smokers has resulted in a shift in cancer diagnoses in which squamous cell carcinomas replaced by more aggressive adenocarcinoma as the most common form of lung cancer in much of the world (Brooks et al. 2005; Ito et al. 2011).

Environmental concerns

Discarded cigarette filters contain residue from chemicals used in tobacco cultivation and cigarette production,

including pesticides, herbicides, insecticides, fungicides, rodenticides, arsenic, nicotine, polycyclic aromatic hydrocarbons, and heavy metals (Moerman and Potts 2011; Slaughter et al. 2011). Cellulose acetate filters are photodegradable but not biodegradable, meaning the source material eventually becomes diluted in water and soil (Novotny et al. 2009). A 2009 study found that discarded filters eluted nicotine; arsenic; heavy metals including lead, copper, chromium and cadmium; and polycyclic aromatic hydrocarbons (PAHs) (Moriwaki et al. 2009). Arsenic, cadmium, and lead are included on the WHO's list of 10 chemicals of major public health concern (WHO 2016), while PAHs are carcinogenic, mutagenic, and teratogenic and the US Environmental Protection Agency (EPA) has designated 16 PAHs as priority pollutants (US EPA 2016). These findings were confirmed by Moerman and Potts (2011) who described cigarette litter as a point source for metal contamination, including aluminium, barium, cadmium, chromium, copper, iron, lead, manganese, nickel, strontium, titanium, and zinc.

The environmental health impact of chemicals leached into soil and water from cigarette butts is still to be quantified. However, the volume of filters discarded into the environment (e.g. Ocean Conservancy 2015), and identification of residual wastes from medicines, pesticides, and plastic microbeads used in cosmetics in water sources suggests that filter leachates may affect the quality of drinking water, constitute an environmental contaminant, and result in bioaccumulation in the food chain that could pose a human health hazard (Novotny et al. 2015).

Register's (2000) analysis of the freshwater daphnid (water flea), *Daphnia magna*, was the first in-depth analysis of the toxicological impacts of cigarette butt waste. Daphnids placed in a test solution of cigarette butts in distilled, deionised water, using the US EPA's 1996 standardised aquatic invertebrate acute toxicity test, revealed a "biohazard to the water flea at concentrations of more than 0.125 butts per litre, or about one butt per two gallons [7.57 L] of water" (Register 2000). While acknowledging that the precise level of real-world exposure of *Daphnia magna* to cigarette butt leachates was yet to be determined, Register argued that the results nonetheless "reveal relevant patterns" of exposure. Subsequent analysis has included studies of *Vibrio fischeri* (a gram-negative bacterium found in marine environments) and *Ceriodaphnia* cf. *dubia* (a freshwater flea) by Micevska et al. (2006), which found varying levels of sensitivity to cigarette butt leachates between the two organisms, that nicotine and ethylphenol were the primary toxicological compounds, and that different cigarette brands created different levels of toxicity.

Studies of larger species have returned similar results. Slaughter et al. (2011) compared the impacts of leachates

from unsmoked cigarette filters containing no tobacco, smoked cigarette filters containing no tobacco, and smoked cigarette butts consisting of smoked filters and tobacco, on marine topsmelt (*Atherinops affinis*) and freshwater fathead minnow (*Pimephales promelas*). Like Register, Slaughter and colleagues used a US EPA standard acute bioassay, and found that all three types of cigarette waste were acutely toxic to marine and freshwater fish, that remnant tobacco contributes to "a degree of toxicity above that which was conferred by the smoked filter alone", and that smoking increased the toxicity of cigarette filters (Slaughter et al. 2011).

More recently, researchers in Taiwan reported that embryos of medaka (also known as the Japanese rice fish, *Oryzias latipes*) exposed to low concentrations of leachates from unignited tobacco and filters showed elevated heart rates and accelerated development, while high concentrations resulted in lowered heart rate, suppressed development, and increased mortality (Lee and Lee 2015). Research conducted into the impact of filter leachates on tide pool snails in Australia found a 100% mortality rate among all species subjected to leachate concentration from five cigarette butts per litre soaked for 2 h, after eight days. Lower concentrations led to species-specific differences in mortality (Booth et al. 2015). Roder Green et al. (2014) measured toxicological impacts of cigarette butt leachate in urban water supplies in Berlin and found that each discarded cigarette butt has the potential to "release nicotine in concentrations higher than the threshold value of hazardous and toxic waste defined by the European Union", thus posing a significant threat to urban waterways.

Economic costs

While a comprehensive analysis of the costs of tobacco product waste clean-up has not been done, estimates and small-scale studies point to a significant investment that is borne, for the most part, by municipal-level governments. Litter clean-up in the US costs USD 11 billion annually (Keep America Beautiful 2010), and cigarette butts comprise an estimated 25–50% of all litter items collected (Healton et al. 2011). Analysis of the direct cost of butt litter clean-up in San Francisco by Schneider et al. (2011), based on street sweeping and sewage treatment plant filtration systems costs, found the total 'recoverable' annual cost of butt litter across the city to be approximately USD 6.5 million.

Further economic cost, and significant loss of life, is caused by residential and wild fires. While the number of home structure fires caused by smoking in the US has dropped significantly in the past 35 years (Hall Jr. 2013), it remains the third most common cause of residential fire resulting in fatality. In 2014, smoking-related fires

accounted for 325 deaths and 775 injuries at an estimated cost of slightly less than USD 230 million (US Fire Administration 2016).

Response and policy actors

The tobacco industry has been concerned for more than three decades that aesthetic and environmental concerns related to cigarette butt litter could contribute to the growing social unacceptability of smoking, advocacy action by tobacco control and environmental organisations, and regulation that holds cigarette manufacturers responsible for litter disposal (Smith and Novotny 2011). Just as it has refused to accept responsibility for smoking-related diseases, tobacco industry response to butt litter has been to shift responsibility for cigarette disposal onto smokers.

The release of the previously confidential tobacco industry documents, the result of litigation in the US since 1998, has provided valuable insights into a range of industry activities (MacKenzie and Holden 2016). The more than 88 000 000 pages in 14 618 911 documents publicly available online as of August 2016 (University of California, San Francisco. Library 2016) reveal what has been described as “the dishonest and starkly cynical nature” of transnational tobacco companies (Blanke 2002). The documents are remarkably diverse in content and format, and include industry discussions on growing environmental concerns about discarded butts among consumers and policymakers (Novotny et al. 2009).

Analysis of the documents by Smith and McDaniel (2011) demonstrates that the strategies of leading cigarette manufacturers have been to prevent butt litter becoming part of discussion around social acceptability of smoking; to avoid regulation; and to “ensure that cigarette manufacturers were not held practically or financially responsible for cigarette litter”. The industry has also recognised, however, that shifting responsibility wholly onto smokers runs the risk of alienating customers, while ignoring the problem would imply indifference, which could have negative public relations impacts. Efforts to create an image of industry concern have included smoker education, installation of street disposal bins, supplying personal ashtrays, and developing alliances with and providing financial support to environmental organisations including Keep America Beautiful.

Research into anti-litter partnerships between Keep America Beautiful, other environmental groups, and leading manufacturers British American Tobacco (BAT), Philip Morris (PM), and RJ Reynolds (RJR) reveals that they generated media coverage that focused on industry-preferred solutions such as volunteer clean-up campaigns and installation of street ashtrays. It was also found that reports mentioning Keep America Beautiful’s participation were

more often positive in their reporting of the tobacco industry, despite partnership initiatives achieving no significant change in levels of discarded cigarette butts (Smith and McDaniel 2011). Similar alliances have been established in other countries. The United Kingdom Tobacco Manufacturers Association, which represents BAT, Gallaher, and Imperial Tobacco, has established close links with Keep Britain Tidy (Rath et al. 2012), while Keep America Beautiful has affiliates in the Bahamas, Bermuda, Canada, South Africa, and Australia that have, or previously had, links with the tobacco industry (Smith and McDaniel 2011).

Potential implications for environmental organisations of such associations and benefits for the tobacco industry are examined in McDaniel and Malone’s (2012) analysis of BAT’s partnership with the United Kingdom-based Earthwatch Europe, a conservation science NGO. Their findings indicate that BAT joined Earthwatch’s Corporate Environmental Responsibility Group in 1990 and in 1998 approached the organisation with a proposal to establish a more formal relationship. Following internal discussions of the ethical implications of working with a leading cigarette manufacturer, Earthwatch accepted BAT’s proposal based on “a narrow view of its own overall organizational mission” (McDaniel and Malone 2012), and delayed making the arrangement public to protect its reputation.

Earthwatch did, however, promote the partnership with policymakers and within the NGO community in return for approximately £100 000 annually in financial support from BAT between 1999 and 2010. The alliance, the authors argue, demonstrates the ability of tobacco companies to use NGOs, including those involved in seemingly unrelated areas of advocacy, to advance tobacco industry interests (McDaniel and Malone 2012). This appears to remain the case despite BAT’s financial support of Earthwatch later being made public (Earthwatch 2016).

The company’s ability to subsequently expand its links to conservancy organisations is demonstrated by the British American Tobacco Biodiversity Partnership (2011) which, as well as the Earthwatch Institute, included Fauna & Flora International and the Tropical Biology Association during its operation from 2001 to 2015. Beyond corporate promotion (British American Tobacco Biodiversity Partnership 2011), the partnership also generated positive coverage in a leading United Kingdom daily newspaper that portrayed BAT as “the only international company to have assessed biodiversity risks across all operations and so built a strategy to tackle key issues worldwide” (Beavis 2011).

Such alliances are important examples of broader tobacco industry corporate social responsibility strategies. Given rates of mortality and morbidity caused by smoking, the concept of socially responsible cigarette manufacturers

is considered by many as inherently contradictory (WHO Tobacco Free Initiative 2003; McDaniel and Malone 2012). Palazzo and Richter (2005), however, distinguish between *transformational* corporate social responsibility, in which a corporation “demonstrates that it is willing to transcend self-interest for the sake of the common good”, and a *transactional* approach in which corporations publicise their compliance with legal and moral obligations, and make claims of fair and consistent behaviour. This second approach, they argue, remains available to the tobacco industry, but as Fooks and Gilmore (2013) have shown in their analysis of BAT, corporate social responsibility initiatives can be used effectively to counteract criticism, and to influence the tobacco control agenda by pre-empting legislation.

Proposals for regulation and policy

In 1999, Novotny and Zhao proposed a series of measures to deal with butt waste: improved enforcement of existing litter laws; additional taxes on tobacco products to be used for environmental clean-up of production and consumption waste; provision of disposal facilities outside worksites and public buildings; and improved biodegradability of filters (Novotny and Zhao 1999). Subsequent analysis of tobacco industry strategies revealed by the release of the industry documents has resulted in potential remedies that more explicitly place the onus for dealing with cigarette waste onto cigarette manufacturers. Smith and McDaniel (2011), for example, argue that the issue of discarded cigarette butts should be reframed as one of *waste* versus *litter*. Litter, they argue, makes the problem one of disposal; waste, conversely, redirects the focus of responsibility to the producer.

Witkowski’s (2014) assessment of possible legal remedies in the US concludes that governments could utilise public nuisance law, which rests on the premise of the right to not be subjected to annoyance or inconvenience that interferes with common public rights. In this case, the public right is to be free of unsightly accumulations of discarded cigarette butts, and of inappropriately disposed toxic materials. Other suggested approaches include the use of state-level hazardous waste law, and product liability law based on the negligent design of cigarette filters and the failure of tobacco companies to warn smokers of associated environmental risks (Witkowski 2014).

Freiberg (2014) argues for pre-emptive legislation, rather than litigation, citing bills introduced in California in 2014 to ban the sale or distribution of any cigarette containing a single-use filter (California State Assembly Democratic Caucus 2014), and in Maryland in 2013 to prohibit non-biodegradable cigarette filters. While both were defeated, these bills raised the profile of the issue and

may represent a future way forward. Freiberg also raises the potential of more specific proposals, in particular a ban on all products containing the chemical bisphenol-A (BPA), including cigarette filters and a range of other consumer products, or application of existing restrictions on products containing pesticide and harmful chemical residue. He notes that a number of states have passed laws similar in intent, such as Maine which has restricted the use of *Ethylenebis* (dithiocarbamate) pesticides which are probable carcinogens (Freiberg 2014).

Increasingly, discussion of regulation has focused on ‘Product Stewardship’ and ‘Extended Producer Responsibility’ (EPR). Product Stewardship initiatives typically include the consumer and retailer as parties subject to regulation. EPR, described by Lindhqvist (2000) as a “protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the producer of the product responsible for the entire life cycle of the product, and especially for the take-back, recycling and final disposal of the product”, explicitly puts the onus of waste management of products on the manufacturer.

Barnes’ (2011) review of EPR regulation in the US found that 32 states had enacted laws covering consumer products including automobile parts, mobile phones, mercury thermostats, paint, and pesticide containers that could serve as models for legislation on cigarette waste. However, existing EPR regulation varies, so that while disposal of new car batteries and tyres are the responsibility of the retailer, most other waste is the responsibility of the consumer. He also notes that enactment of effective EPR regulation requiring cigarette manufacturers to implement solutions for collection, transportation, and safe disposal of discarded cigarette butts would remove the economic and administrative burden from state and local government.

Curtis et al. (2014) recommended regulation that combines aspects of EPR, Product Stewardship, the Polluter Pays Principle, and the Precautionary Principle. Specific measures would include bans on single-use filters, product labelling, litigation against the tobacco industry, and waste and litter fees. Following Barnes (2011), the authors cite the precedent making retailers responsible for post-consumer disposal of car tyres and batteries. This multifaceted approach would “prevent, reduce and mitigate [tobacco product waste’s] environmental effects” by sharing responsibility for waste across the lifecycle of the product and shifting the economic costs of clean-up to the producers of the toxic product, in this case the tobacco companies (Curtis et al. 2014).

At the international policy level, the scale of butt littering has led to a growing awareness of associated problems among parties to the WHO’s Framework Convention on Tobacco Control (FCTC) (Javadian et al. 2015).

Novotny et al. (2015) have recommended that relevant Articles of the FCTC, particularly Article 18 *Protection of the environment and health of persons*, be brought to bear. The underlying tenet of the FCTC, to challenge the tobacco industry and its vested interests, they argue, can be used to support prohibition of single-use filters; litigation and economic interventions aimed at recovery of costs of industry misconduct and environmental damages; and to “innovate, improve and enforce new and existing environmental regulations and agreements” that apply to all stages of tobacco production and post-consumption waste (Novotny et al. 2015).

While significant regulation is yet to be enacted, potential industry response can be gauged by its reaction to San Francisco’s imposition of a waste clean-up levy fee of US \$0.20 per pack on cigarettes sold in the city. Freiberg (2014) describes the tobacco industry’s unsuccessful legal challenge to the regulation on the grounds that it represented an unauthorised tax, and by its significant financial support of California’s Proposition 26, a state initiative aimed at limiting the ability of local jurisdictions to adopt similar measures (Ballotpedia 2010). Philip Morris, for instance, contributed USD 1.75 million to “Stop Hidden Taxes”, a ‘front group’ funded by alcohol, tobacco, oil, and business interests to support the passage of Proposition 26.

Australia

Despite declining smoking rates, 20 billion cigarettes are consumed annually in Australia, resulting in an estimated 7 billion cigarette butts being discarded into the environment (Scollo and Winstanley 2015). Cigarette butts were the most frequently identified litter item in 2014–2015, at 22 butts per 1000 m² (Keep Australia Beautiful 2015). Street cleaners in Sydney, the country’s largest city, collect a reported 15 000 cigarette butts each day, or nearly 5.5 million annually (City of Sydney 2016), while a litter clean-up covering just 200 metres of St Kilda Beach in Melbourne recovered 5000 butts, 25 per metre of beach (BeachPatrol 2016). Smoking is also the leading cause of fire deaths in Australia, with 7% of all bushfires caused by discarded cigarette butts and matches (Australian Bureau of Statistics 2006) despite a 2010 regulation that requires all cigarettes sold to incorporate reduced fire risk design features (Australian Competition and Consumer Commission 2016).

Policy response has been limited. The background paper to the *Threat abatement plan for the impacts of marine debris on vertebrate marine life* (Australian Government, Department of the Environment, Water, Heritage and the Arts 2009) is one of few government plans that address litter in terms of its potential environmental harms. It includes cigarette butts among its list of harmful marine

debris but regulation is currently focused on a much broader definition of litter, and particularly plastics. At the state level, New South Wales’ *Waste Avoidance and Resource Recovery Act 2001* provides for EPR schemes similar to those already discussed. The NSW EPA forms a part of a coordinated effort across other Australian jurisdictions to develop national product stewardship requirements (New South Wales, Environment Protection Authority 2015). If successfully implemented, a national EPR scheme may constitute an effective regulatory response, if it meaningfully holds cigarette manufacturers responsible for the entire lifecycle of their products. Current policy, however, continues to focus on disposal infrastructure and smoker education.

Previous research indicates that tobacco industry efforts to influence the policy debate around litter and responsibility, described above, have extended to Australia (Smith and McDaniel 2011), and preliminary analysis of annual reports, submissions, and websites of Australian tobacco companies and environmental organisations provide further evidence of these links. One particularly explicit example is the Butt Littering Trust, established by British American Tobacco Australia (BATA) in 2003. Chapman’s (2006) analysis of the Trust found that it focused on education campaigns, and that BATA start-up funding was AUD 2.8 million over four years.

BATA remains a key funder of the organisation (re-named Butt Free Australia in 2009–2010), although it was acquired by Keep South Australia Beautiful (KESAB) *environmental solutions* in January 2012 (Butt Free Australia 2016). The company’s 2012 submission to the national Standing Council on Environment and Water’s Packaging Impacts Consultation Regulation Impact Statement notes that BATA’s “direct financial contribution to the Trust and other butt litter reduction initiatives” had exceeded AUD 5 million since 2002 (BATA 2012).

Other, ongoing partnerships and sponsorships between the Australian tobacco industry and KESAB are listed in other recent submissions and reports (BATA 2012; KESAB 2015a, b). The effectiveness of these programmes was questioned by the New South Wales’ Department of Environment and Conservation as early as 2006, in a report on extended producer responsibility which noted that the “impact of current activities funded by cigarette manufacturers has not delivered a reduction in butt littering” (New South Wales, Department of Environment and Conservation 2006).

Another potential research resource is the Australian Packaging Covenant, a voluntary agreement between government and industry launched in 1999 to find solutions to minimise the environmental impacts of packaging waste through improved design and production processes and increased re-use and recycling of used packaging

(Australian Packaging Covenant 2011). BATA, Imperial Tobacco Australia, and Philip Morris Limited are among the more than 900 signatories to the agreement, and have submitted action plans and annual progress reports that highlight the need for education, butt disposal infrastructure and industry donations to KESAB (BATA 2015; Imperial Tobacco Australia 2015). Reporting to the Australian Packaging Covenant also affords the industry corporate social responsibility opportunities. Philip Morris Limited, for example, emphasises that it does “not classify cigarette butts as part of the packaging of tobacco products” (Philip Morris Limited 2010).

The company has, however, used its annual reports to the Covenant to draw attention to its formation, with competitor companies, of the Tobacco Industry Product Stewardship initiative that in 2014 funded cigarette butt recycling projects with the Australia branch of the international recycling organisation Terracycle (Philip Morris Limited 2015). Echoing schemes in other countries, Australians were invited to send collected butts using post-paid labels to Terracycle, which donated two cents (per kilogram of butts) to the school or charity of the donor’s choice (Australian Manufacturing 2014; Terracycle 2014). When industry funding was withdrawn without public explanation in December 2015, the 10.5 million butts that had been collected over the two years of the programme (Clean Up Australia 2016) represented an inconsequential proportion of the estimated 7 billion discarded into the environment annually.

The lesson arising from such associations between environmental groups and the tobacco industry for the tobacco control community and other advocacy groups, according to Smith and McDaniel (2011), is to pursue alliances with groups founded on the key environmental principles ‘reduce, reuse, recycle’. A useful practical starting point for researchers and advocates is the California Department of Public Health’s *Tobacco Product Waste Reduction Toolkit* (Novotny 2013) which provides useful information on establishing partnerships, as well as related science, methods for estimating clean-up costs, developing policy response, and mounting advocacy campaigns.

CONCLUSION

Although evidence exists in Australia that highlights the potential impacts of discarded cigarette butts, there is a need for further research similar to that carried out elsewhere, particularly into toxicology, environmental impacts on extensive and biodiverse coastlines and wildlife, and the policy process.

Environmental organisations are the seemingly natural partners for the tobacco control community in pursuing

such research initiatives, but evidence of relationships of some environmental groups with the tobacco industry makes identifying potential allies a complicated undertaking. Research into possible policy response will need to include the role of the tobacco industry. Analysis described above points to some of the resources that could be used in such research including tobacco industry documents, submissions to government agencies, annual reports and publicity released by cigarette manufacturers, and similar material produced by environmental groups. These resources constitute a potentially valuable source of information on tobacco industry strategies to direct policy discussions towards largely ineffective disposal infrastructure, public education programmes, and well-publicised clean-up events, often in conjunction with environmental NGOs.

Australia has a relatively small population and a low national smoking prevalence, yet approximately 7 billion cigarette butts are discarded into the environment every year. This not only suggests the scale and potential impacts of butt litter in countries with larger populations and much higher smoking rates, but also highlights the obvious international applications of the research directions outlined above.

Acknowledgements This work was supported by the National Cancer Institute, US National Institutes of Health, Grant R01-CA091021 (RJM).

REFERENCES

- Australian Bureau of Statistics. 2006. Year Book Australia, 2004: Bushfires. <http://www.abs.gov.au/ausstats/abs@.nsf/0/ccb3f2e90ba779d3ca256dea00053977>. Retrieved 22 July 2016.
- Australian Bureau of Statistics. 2015. National Health Survey: First Results, 2014–2015. <http://www.abs.gov.au/ausstats/abs@.nsf/mf/4364.0.55.001>. Retrieved 22 July 2016.
- Australian Competition and Consumer Commission. 2016. *Product Safety Australia*. <https://www.productsafety.gov.au/>. Retrieved 19 Aug 2016.
- Australian Government, Department of the Environment, Water, Heritage and the Arts. 2009. Background paper for the threat abatement plan for the impacts of marine debris on vertebrate marine life. <http://www.environment.gov.au/system/files/resources/d945695b-a3b9-4010-91b4-914efcdbae2f/files/marine-debris-background-paper.pdf>. Retrieved 14 July 2016.
- Australian Manufacturing. 2014. Terracycle: Australia has already joined the Cigarette Waste Brigade. <http://www.australianmanufacturing.com.au/20221/terracycle-australia-keeps-one-million-cigarette-butts-streets>. Retrieved 14 Aug 2016.
- Australian Packaging Covenant. 2011. *Australian Packaging Covenant: A commitment by governments and industry to the sustainable design, use and recovery of packaging*. http://www.packagingcovenant.org.au/data/Resources/Aust_Packaging_Covenant_amended_10_October_2011.pdf. Retrieved 4 July 2016.
- Ballotpedia. 2010. California Proposition 26, Supermajority Vote to Pass New Taxes and Fees (2010). [http://ballotpedia.org/California_Proposition_26_Supermajority_Vote_to_Pass_New_Taxes_and_Fees_\(2010\)](http://ballotpedia.org/California_Proposition_26_Supermajority_Vote_to_Pass_New_Taxes_and_Fees_(2010)). Retrieved 21 June 2016.

- Barnes, R.L. 2011. Regulating the disposal of cigarette butts as toxic hazardous waste. *Tobacco Control* 20: i45–i48. doi:10.1136/tc.2010.041301.
- BeachPatrol. 2016. Cigarette Butt Litter Surveys. <http://www.beachpatrol.com.au/Cigarette-Litter>. Retrieved 8 Aug 2016.
- Beavis, L. 2011. British American Tobacco—Collaborative effort sees more responsible growing. *The Guardian* 26 May. <https://www.theguardian.com/sustainable-business/collaborative-effort-more-responsible-growing>. Retrieved 15 Aug 2016.
- Blanke, D.D. 2002. *Towards Health with Justice: Litigation and public inquiries as tools for tobacco control*. Geneva: World Health Organization.
- Booth, D.J., P. Gribben, and K. Parkinson. 2015. Impact of cigarette butt leachate on tidepool snails. *Marine Pollution Bulletin* 95: 362–364. doi:10.1016/j.marpolbul.2015.04.004.
- British American Tobacco Australia. 2012. Submission on the packaging impacts consultation regulation impact statement (PICRIS). Submission to the Standing Council on Environment and Water. Retrieved 2 July, 2016, from <http://www.scew.gov.au/system/files/submissions/08131a3d-e461-32e4-ed8d-f151695d5a86/123-british-american-tobacco-aust.pdf>.
- British American Tobacco Australia. 2015. Annual report to the Australian Packaging Covenant. http://www.packagingcovenant.org.au/data/AnnualReports2015/British%20American%20Tobacco%20Australia_AR_2015.pdf. Retrieved 2 July 2016.
- British American Tobacco Biodiversity Partnership. 2011. Progress report. http://www.fauna-flora.org/wp-content/uploads/BAT_Biodiversity_Report.pdf. Retrieved 15 Aug 2016.
- Brooks, D.R., J.H.M. Austin, R.T. Heelan, M.S. Ginsberg, V. Shin, S.H. Olson, J.E. Muscat, and S.D. Stellman. 2005. Influence of type of cigarette on peripheral versus central lung cancer. *Cancer Epidemiology, Biomarkers and Prevention* 14: 576–581. doi:10.1158/1055-9965.EPI-04-0468.
- Butt Free Australia. 2016. About Butt free Australia. <http://www.notagoodlook.com.au/about-butt-free-australia/>. Retrieved 12 July 2016.
- California State Assembly Democratic Caucus. 2014. Stone introduces bill to ban cigarette butts. <http://asmdc.org/members/a29/news-room/press-releases/stone-introduces-bill-to-ban-cigarette-butts>. Retrieved 1 Aug 2016.
- Chapman, S. 2006. Butt clean up campaigns: wolves in sheep's clothing? *Tobacco Control* 15: 273. doi:10.1136/tc.2006.017590.
- Chapman, S. 2016. Ten more myths about smoking that will not die. *The Conversation*, 17 March. <https://theconversation.com/ten-more-myths-about-smoking-that-will-not-die-56419>. Retrieved 1 Aug 2016.
- City of Sydney. 2016. Cigarette butts: yuk. <http://www.cityofsydney.nsw.gov.au/live/waste-and-recycling/clean-streets/yuk-cigarette-butts>. Retrieved 19 Aug 2016.
- Clean Up Australia. 2015. Cigarette butts fact sheet. http://www.cleanup.org.au/files/clean_up_australia_cigarette_butts_factsheet.pdf. Retrieved 12 June 2016.
- Clean Up Australia. 2016. Butt recycling campaign shut down by the tobacco industry. <http://www.cleanup.org.au/au/Whatelsewesupport/recycling-cigarette-butts.html>. Retrieved 14 June 2016.
- Curtis, C., S. Collins, S. Cunningham, P. Stigler, and T.E. Novotny. 2014. Extended producer responsibility and product stewardship for tobacco product waste. *International Journal of Waste Resources* 4: 157. doi:10.4172/2252-5211.1000157.
- Earthwatch. 2016. Partner profile: British American Tobacco (BAT). <http://au.earthwatch.org/corporate-partnerships/partnership-profiles/british-american-tobacco-bat>. Retrieved 15 Aug 2016.
- Fooks, G.J., and A.B. Gilmore. 2013. Corporate philanthropy, political influence, and health policy. *PLoS ONE* 8: e80864. doi:10.1371/journal.pone.0080864.
- Freiberg, M. 2014. (Don't) see more butts: Preemption and local regulation of cigarette litter. *Hamline Law Review* 37(1): 205–228. <http://digitalcommons.hamline.edu/hlr/vol37/iss1/6>.
- Hall Jr., J.R. 2013. The Smoking-Material Fire Problem. National Fire Protection Association. <http://www.nfpa.org/news-and-research/fire-statistics-and-reports/fire-statistics/fire-causes/smoking-materials>. Retrieved 16 June 2016.
- Healton, C.G., K.M. Cummings, R.J. O'Connor, and T.E. Novotny. 2011. Butt really? The environmental impact of cigarettes. *Tobacco Control* 20: i1. doi:10.1136/tc.2011.043729.
- Imperial Tobacco Australia. 2015. Annual report to the Australian Packaging Covenant. http://www.packagingcovenant.org.au/data/AnnualReports2015/Imperial%20Tobacco%20Australia%20Limited_AR_2015.pdf. Retrieved 12 June 2016.
- Ito, H., K. Matsuo, H. Tanaka, D.C. Koestler, H. Ombao, J. Fulton, A. Shibata, M. Fujita, et al. 2011. Nonfilter and filter cigarette consumption and the incidence of lung cancer by histological type in Japan and the United States: Analysis of 30-year data from population-based cancer registries. *International Journal of Cancer* 128: 1918–1928. doi:10.1002/ijc.25531.
- Javadian, S., P. Stigler-Granados, C. Curtis, F. Thompson, L. Huber, and T.E. Novotny. 2015. Perspectives on tobacco product waste: A survey of Framework Convention Alliance members' knowledge, attitudes, and beliefs. *International Journal of Environmental Research and Public Health* 12: 9683–9691. doi:10.3390/ijerph120809683.
- Jha, P. 2009. Avoidable global cancer deaths and total deaths from smoking. *Nature Reviews Cancer* 9: 655–664. doi:10.1038/nrc2703.
- Keep America Beautiful. 2010. Litter in America: Results from the nation's largest litter study. https://www.kab.org/sites/default/files/News%26Info_Research_LitterinAmerica_FactSheet_CostsofLittering.pdf. Retrieved 14 June 2016.
- Keep Australia Beautiful. 2015. National Litter Index. Annual Report: 2014/2015. <http://kab.org.au/litter-research/national-litter-index/>. Retrieved 14 June 2016.
- Keep South Australia Beautiful [KESAB environmental solutions]. 2015a. Annual Report 2014/2015. <http://www.kesab.asn.au/wp-content/uploads/annual-reports/KESAB-Annual-Report-2014-2015.pdf>. Retrieved 18 June 2016.
- Keep South Australia Beautiful [KESAB environmental solutions]. 2015b. Response to Green Industries SA Consultation Paper. <http://www.zerowaste.sa.gov.au/upload/green-industries-sa/green-industries-sa-consultation-responses/999%20KESAB.pdf>. Retrieved 18 June 2016.
- Kozlowski, L.T., and R.J. O'Connor. 2002. Cigarette filter ventilation is a defective design because of misleading taste, bigger puffs, and blocked vents. *Tobacco Control* 11: i40–i50. doi:10.1136/tc.11.suppl_1.i40.
- Lee, W., and C.C. Lee. 2015. Developmental toxicity of cigarette butts—An underdeveloped issue. *Ecotoxicology and Environmental Safety* 113: 362–368. doi:10.1016/j.ecoenv.2014.12.018.
- Lindhqvist, T. 2000. Extended producer responsibility in cleaner production: Policy principle to promote environmental improvements of product systems. Doctoral Thesis, Lund University, Sweden. <http://lup.lub.lu.se/luur/download?func=downloadFile&recordId=19692&fileId=1002025>. Retrieved 4 June 2016.
- MacKenzie, R., and C. Holden. 2016. Analysing corporate documents. In *Researching corporations and global health governance: An interdisciplinary guide*, ed. K. Lee, and B. Hawkins. London: Rowman & Littlefield.
- Mathers, C.D., and D. Loncar. 2006. Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Medicine* 3: e442. doi:10.1371/journal.pmed.0030442.
- McDaniel, P.A., and R.E. Malone. 2012. British American Tobacco's partnership with Earthwatch Europe and its implications for

- public health. *Global Public Health* 7: 14–28. doi:10.1080/17441692.2010.549832.
- Micevska, T., M.S.J. Warne, F. Pablo, and R. Patra. 2006. Variation in, and causes of, toxicity of cigarette butts to a cladoceran and Microtox. *Archives of Environmental Contamination and Toxicology* 50: 205–212. doi:10.1007/s00244-004-0132-y.
- Moerman, J.W., and G.E. Potts. 2011. Analysis of metals leached from smoked cigarette litter. *Tobacco Control* 20: i30–i35. doi:10.1136/tc.2010.040196.
- Moriwaki, H., S. Kitajima, and K. Katahira. 2009. Waste on the roadside, 'poi-sute' waste: Its distribution and elution potential of pollutants into environment. *Waste Management* 29: 1192–1197. doi:10.1016/j.wasman.2008.08.017.
- New South Wales, Department of Environment and Conservation. 2006. NSW Extended Producer Responsibility Priority Statement 2005–2006. <http://epa.nsw.gov.au/resources/waste/050624-epr-priority-0506.pdf>. Retrieved 23 Aug 2016.
- New South Wales, Environment Protection Authority. 2015. Product stewardship schemes. <http://www.epa.nsw.gov.au/wastestrategy/stewardship-schemes.htm>. Retrieved 23 Aug 2016.
- Novotny, T. 2013. Tobacco product waste reduction toolkit. California Department of Public Health, California Tobacco Control Program. Sacramento. https://www.cdph.ca.gov/programs/tobacco/Documents/CDPH%20CTCP%20Refresh/Community/Toolkits%20and%20Manuals/Tobacco_Product_Waste_Reduction_Toolkit.pdf. Retrieved 27 Oct 2016.
- Novotny, T.E., and E. Slaughter. 2014. Tobacco product waste: An environmental approach to reduce tobacco consumption. *Current Environmental Health Reports* 1: 208–216. doi:10.1007/s40572-014-0016-x.
- Novotny, T.E., and F. Zhao. 1999. Consumption and production waste: Another externality of tobacco use. *Tobacco Control* 8: 75–80. doi:10.1136/tc.8.1.75.
- Novotny, T.E., K. Lum, E. Smith, V. Wang, and R. Barnes. 2009. Cigarettes butts and the case for an environmental policy on hazardous cigarette waste. *International Journal of Environmental Research and Public Health* 6: 1691–1705. doi:10.3390/ijerph6051691.
- Novotny, T.E., S. Aguinaga Bialous, L. Burt, C. Curtis, V. Luiza da Costa, S. Usman Iqtidar, Y. Liu, S. Pujari, et al. 2015. The environmental and health impacts of tobacco agriculture, cigarette manufacture and consumption. *Bulletin of the World Health Organization* 93: 877–880. doi:10.2471/BLT.15.152744.
- Öberg, M., A. Woodward, M.S. Jaakkola, A. Peruga, and A. Prüss-Ustün. 2010. Global estimate of the burden of disease from second-hand smoke. Geneva: World Health Organization. http://www.who.int/tobacco/publications/second_hand/global_estimate_burden_disease/en/. Retrieved 5 Aug 2016.
- Ocean Conservancy. 2015. International coastal cleanup: 2015 Report. <http://www.oceanconservancy.org/our-work/marine-debris/2015-data-release/2015-data-release-pdf.pdf>. Retrieved 11 June 2016.
- Palazzo, G., and U. Richter. 2005. CSR business as usual? The case of the tobacco industry. *Journal of Business Ethics* 61: 387–401. doi:10.1007/s10551-005-7444-3.
- Philip Morris Limited. 2010. Australian Packaging Covenant Action Plan July 2010–June 2015. http://www.packagingcovenant.org.au/data/ActionPlans/Philip%20Morris%20Limited_AP.pdf. Retrieved 17 June 2016.
- Philip Morris Limited. 2015. Annual report to the Australian Packaging Covenant. http://www.packagingcovenant.org.au/data/AnnualReports2015/Philip%20Morris%20Limited_AR_2015.pdf. Retrieved 11 June 2016.
- Proctor, R.N. 2012. *Golden holocaust: Origins of the cigarette catastrophe and the case for abolition*. Oakland: University of California Press.
- Rath, J.M., R.A. Rubenstein, L.E. Curry, S.E. Shank, and J.C. Cartwright. 2012. Cigarette litter: Smokers' attitudes and behaviors. *International Journal of Environmental Research and Public Health* 9: 2189–2203. doi:10.3390/ijerph9062189.
- Register, K.M. 2000. Cigarette butts as litter—Toxic as well as ugly. *Underwater Naturalist* 25. <http://www.longwood.edu/cleanva/ciglitterarticle.htm>. Retrieved 25 July 2016.
- Roder Green, A.L., A. Putschew, and T. Nehls. 2014. Littered cigarette butts as a source of nicotine in urban waters. *Journal of Hydrology* 519: 3466–3474. doi:10.1016/j.jhydrol.2014.05.046.
- Schneider, J.E., N.A. Peterson, N. Kiss, O. Ebeid, and A.S. Doyle. 2011. Tobacco litter costs and public policy: A framework and methodology for considering the use of fees to offset abatement costs. *Tobacco Control* 20: i36–i41. doi:10.1136/tc.2010.041707.
- Scollo, M.M., and M.H. Winstanley. 2015. Tobacco in Australia: Facts and issues. Melbourne: Cancer Council Victoria. www.TobaccoInAustralia.org.au. Retrieved 2 June 2016.
- Slaughter, E., R.M. Gersberg, K. Watanabe, J. Rudolph, C. Stransky, and T.E. Novotny. 2011. Toxicity of cigarette butts, and their chemical components, to marine and freshwater fish. *Tobacco Control* 20: i25–i29. doi:10.1136/tc.2010.040170.
- Smith, E.A., and P.A. McDaniel. 2011. Covering their butts: Responses to the cigarette litter problem. *Tobacco Control* 20: 100–106. doi:10.1136/tc.2010.036491.
- Smith, E.A., and T.E. Novotny. 2011. Whose butt is it? Tobacco industry research about smokers and cigarette butt waste. *Tobacco Control* 20: i2–i9. doi:10.1136/tc.2010.040105.
- Stratton, K., P. Shetty, R. Wallace, and S. Bondurant (eds.). 2001. *Cleaning the smoke: Assessing the science base for tobacco harm reduction*. Washington: National Academy Press.
- Terracycle. 2014. Cigarette waste is now recyclable in Australia. <http://journalists.medianet.com.au/DisplayAttachment.aspx?j=796561&s=2&k=9948754>. Retrieved 19 July 2016.
- United States Department of Health and Human Services. 2010. How tobacco smoke causes disease: The biology and behavioral basis for smoking-attributable disease: A report of the Surgeon General. Atlanta: US DHHS, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.
- United States Environmental Protection Agency. 2016. Toxic and priority pollutants under the Clean Water Act. <https://www.epa.gov/eg/toxic-and-priority-pollutants-under-clean-water-act>. Retrieved 5 Aug 2016.
- United States Fire Administration. 2016. Data, publications and library. <https://www.usfa.fema.gov/data/>. Retrieved 5 Aug 2016.
- University of California, San Francisco. Library. 2016. Tobacco industry documents. <https://industrydocuments.library.ucsf.edu/tobacco/>. Retrieved 6 Aug 2016.
- Warner, K.E. 2002. Tobacco harm reduction: Promise and perils. *Nicotine & Tobacco Research* 4: S61–S71. doi:10.1080/1462220021000032825.
- Witkowski, J. 2014. Holding cigarette manufacturers and smokers liable for toxic butts: Potential litigation-related causes of action for environmental injuries/harm and waste cleanup. *Tulane Environmental Law Journal* 28: 1–36.
- World Health Organization. Tobacco Free Initiative. 2003. *Tobacco industry and corporate responsibility...an inherent contradiction*. Geneva: WHO.

World Health Organization. 2016. International Programme on Chemical Safety: Ten chemicals of major public health concern. http://www.who.int/ipcs/assessment/public_health/chemicals_phc/en/. Retrieved 28 June 2016.

AUTHOR BIOGRAPHIES

Lucinda A. Wallbank is pursuing her Masters degree at Macquarie University in Sydney, Australia. Her research interests include the tobacco industry, food security and health, and the impacts of climate change on health.

Address: Department of Environmental Sciences, Faculty of Science and Engineering, Macquarie University, Sydney, NSW 2109, Australia.

e-mail: lucinda.wallbank@mq.edu.au

Ross MacKenzie (✉) is a Lecturer in Health Studies at Macquarie University in Sydney, Australia. His research areas include the tobacco industry, global health governance, and environmental health. *Address:* Department of Psychology, Faculty of Human Sciences, Macquarie University, Sydney, NSW 2109, Australia. e-mail: ross.mackenzie@mq.edu.au

Paul J. Beggs is an Associate Professor at Macquarie University in Sydney, Australia. His research interests include environmental health, impacts of climate change on human health, and allergens and allergic diseases

Address: Department of Environmental Sciences, Faculty of Science and Engineering, Macquarie University, Sydney, NSW 2109, Australia.

e-mail: paul.beggs@mq.edu.au