

CIRCULAR ECONOMY IN THE OUTDOOR INDUSTRY: ASSESSING
PROGRESS, CHALLENGES, AND OPPORTUNITIES IN DEVELOPING
CIRCULAR PRODUCT MODELS FOR OUTDOOR HARD GOODS
PRODUCTS

by

Greg Gausewitz

Dr. Daniel Vermeer, Advisor

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EXECUTIVE SUMMARY

In a world with a growing population, and growing demand for products, circular product models are thought to provide a unique opportunity to satisfy consumer demand while significantly reducing the environmental impacts associated with product manufacturing. At the same time, practical, scalable examples of such models are not commonplace. The aim of this report is two-fold. First, it seeks to further explore the progress made to date in developing circular product models¹. Second, it aims to identify key challenges and opportunities that impact the expansion of these models.

There is a growing body of research on this topic, much of which focuses on specific product categories. One category that has not been the subject of much research to date is hard goods (products made from hard materials such as metal, plastic, or composites) in the outdoor industry. This category is the focus of this report. A series of product case studies featured in this report will illustrate the state of the deployment of circular product models in these categories by exploring the following questions:

- What progress has been made to date in developing and deploying circular product models in the industry for outdoor hard goods?
- What are the key barriers to the recycling of such products?
- What are the key opportunities to increase the portion of these products that get recycled?

A review of existing literature provided useful background information. Existing literature highlights the factors that led to the development of the “circular economy” concept, which began in the early 1990s. The concept became more commonplace following the 2002 publishing of the McDonough and Braungart book *Cradle to Cradle: Remaking the Way We Make Things*. Much existing research on this topic originates from industry think tanks, such as the Cradle to Cradle Products Innovation Institute and the Ellen MacArthur Foundation. A sizable body of academic and industrial research also exists. The research highlights the various components of circular product models. To summarize, primary components of a circular product model include efforts to (a) design products in a way that enables a circular lifecycle, (b) enable users to derive maximum value from products through means such as product repair, rental, remanufacturing, refurbishing, and re-use, and (c) optimize the fate of products at the end of their useful life. This report focuses primarily on product design and end-of-life, as these two product lifecycle stages are closely linked and are critical to bringing about circular product models.

Seven exploratory product case studies will examine multiple units of analysis related to the research questions above. Six products were selected based on their exemplifying one or more components of a circular product model, and one product was selected as a feasibility analysis to explore hypothetical opportunities to develop this model. Interviews with company representatives provided the information highlighted in the case studies.

The primary finding of the case studies was that, while each product exhibited one or more components of a circular product model, no product exemplified a fully circular model. While the majority of interviewees were familiar with the circular economy concept, none (0) of the companies had a formal circular economy strategy in place. Five (5) of the products contained recycled materials, and four (4) were designed to be disassembled. In addition, while three (3) of the seven products had been shown to be recyclable, none (0) of the products was currently being recycled at a large scale. Finally, none (0) of the companies currently offered a product take-back option for the customers that allowed the company to collect products from customers at end-of life.

¹ In this report, a circular product model is defined as one where the products are made entirely from recycled materials, are fully recyclable, and are actively being recycled. Other definitions may include products that contain compostable materials and are composted at end-of-life. However, because this project focuses on hard goods, which are typically made from durable materials that are not compostable, this report will focus primarily on recycling rather than composting.

The case studies also elucidated trends in the barriers and challenges encountered by the companies. The most common challenges – identified by each (7) of the seven companies – were a lack of infrastructure for (a) collecting products at end-of life and separating and sorting component materials and (b) recycling products' component materials. Additional challenges identified were the lack of recyclability of individual product materials; cost, quality, and availability of recycled materials; and the complexity of products, which made product disassembly difficult. Interviews with organizations that handle or conduct research on waste and the circular economy provided additional contextual information that is highlighted in the report.

The product case studies also identified several key opportunities for companies to further deploy circular product models. First, examining material usage across a company's product offering can identify key opportunities to use recycled and/or recyclable materials in products that may be especially conducive to circular models (i.e., products that use large quantities of a limited number of materials and are easily disassembled). Second, integrating circular considerations into the design process can increase the use of recycled and recyclable materials and promote design for disassembly, recyclability, and labeling of materials. Companies seeking to reduce the overall environmental impact associated with their products' lifecycles should also explore opportunities to ensure maximum value is derived from products during their life via product repair, rental, remanufacturing, refurbishing, and re-use. Companies must also be careful not to compromise products' function in pursuit of circular models. Finally, companies can partner with waste management organizations to optimize disposal of their products and identify longer-term opportunities to integrate end-of-life considerations into product design.

In summary, while none of the products highlighted in the report fully embodied a circular product model, their significance should not be underestimated. These models are likely to inform more comprehensive models in the future within these organizations, across the outdoor industry, and beyond. Efforts by companies such as these, combined with additional research and actions taken by various parties across the value chain, are moving the industry toward a state of greater circularity.

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I. INTRODUCTION

In the field of sustainability, the terms “circular economy” or “cradle to cradle” are used often. They refer to an idealized consumer product model where product materials are efficiently recycled back into material inputs or are harmlessly returned to the biosphere at the end of their useful life (the period of a product’s life referred to as “end-of-life”). In a world with a growing population, and growing demand for products, circular product models² are thought to provide a unique opportunity to satisfy consumer demand while significantly reducing the environmental impacts – including raw material consumption, resource usage, waste, and pollution – associated with manufacturing. At the same time, practical, scalable examples of such models are not commonplace.

The aim of this project was to further explore the progress made to date in developing circular product models, and to identify key challenges and opportunities that impact the expansion of these models. Much of the existing research on the topic of circular economy is largely focused on certain categories, including apparel and textiles, electronics, food, and packaging. In order to build upon existing research while seeking to identify specific, tangible barriers and opportunities, this report will focus on a specific product category: products made of hard materials (also known as “hard goods”) intended for outdoor use. The project will place specific emphasis on products made from commonly used and recyclable materials, including metals, plastics, and synthetic textiles. Because this project focuses on hard goods, which are typically made from durable materials that are not compostable, this report will focus primarily on the recycling of materials and not on composting.

To examine the circular economy topic, this report utilizes case studies of products that are currently on the market and exhibit one or more components of a circular product model to explore the following questions:

² In this report, a circular product model is defined as one where the products are made entirely from recycled materials, are fully recyclable, and are actively being recycled.

- What progress has been made to date in developing and deploying circular product models in the industry for outdoor hard goods?
- What are the key barriers to the recycling of such products?
- What are the key opportunities to increase the portion of these products that get recycled?

Overall, the goal of this project is to explore and highlight opportunities to improve and expand the deployment of circular product models.

II. LITERATURE REVIEW

This section provides an overview of key takeaways from existing research on the topic of the circular economy and the development of circular product models.

a. General Background Information

The world's population continues to grow and is expected to reach 9.5 billion people by the year 2050 (ING Economics Department, 2015). At the same time, global economic development continues to increase the intensity of resource usage and overall environmental impact associated with the average human's lifestyle. By 2030, over half the world's population is expected to occupy the middle class, up from roughly a quarter of the global population today. With almost 7.5 billion people currently inhabiting the planet, the health of the global environment is already being significantly impacted (United States Census Bureau, 2018). It is estimated that the world's population currently uses 1.5 times as many resources as the planet can provide in a sustainable manner. Further, if the entirety of the world's population consumed at the rate of the average American, it would require four times the amount of resources that the planet can sustainably provide. The continued prosperity and improved standards of living for individuals around the world is a fundamentally important goal, and the higher-consumption lifestyles that will accompany this growth present a challenge that humankind must overcome.

The process of manufacturing the goods consumed by the world's population is currently highly resource-intensive. In addition to raw materials – which are typically grown or extracted from the earth before being transformed into finished products – inputs such as energy, water, and chemicals facilitate the manufacturing process itself. Products and materials must also often be transported significant distances between various manufacturing locations and points of sale and disposal. Finally, products and their component materials are often disposed of in landfills, where they add no value to society and may contaminate soil and groundwater or cause other environmental harms (United States Environmental Protection Agency [U.S. EPA], 2015).

According to the U.S. EPA (2017), recycling is “the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products”. Recycling of certain products and materials has long served as a means of managing waste and maximizing the value that is extracted from these items. The modern concept of recycling became mainstream in the 1970s as the result of increasing levels of consumption in the developed world and a shift toward more disposable goods and packaging (Werrett, 2013). By the 1990s, many communities in America had access to public recycling collection programs for materials such as paper, plastic, metal, and glass (Cooper, 1998). At the time of this writing, recycling programs facilitate the recycling of these materials with varying degrees of success. Today, roughly 90% of steel and about two-thirds of paper get recycled, while only about a third of glass and less than 10% of plastic get recycled (U.S. EPA, 2017b).

Not all recycling outcomes are equal, however. “Downcycling” is an outcome where recycled materials are of lower quality, functionality, or value than the original material (McDonough & Braungart, 2002). While recycling a material is almost always a better solution than simply disposing of it, downcycling is an undesirable outcome, as it results in materials being continuously shifted to states of lower function or value over time. “Upcycling”, on the other hand, results in materials being recycled and utilized at a state of higher quality, function, or value than the original material. Upcycling is an aspirational concept that offers a glimpse of the potential for recycling to add value to the material manufacturing process and, more broadly, to society.

While recycling has been successful in reducing waste and recapturing value from common products and materials at the end of their useful life, many see an opportunity to rethink the product system and proactively improve product design to better facilitate recycling and other positive outcomes for products at end-of-life. The concept of a “circular economy” was developed in the early 1990s and gained increasing popularity following the release of William McDonough and Michael Braungart’s 2002 book *Cradle to Cradle: Remaking the Way We Make Things*. In the book, the authors envision a circular economy, where products are designed not for a “linear” lifecycle – where materials are extracted, used in products, and then disposed of – but a “circular” one. In a circular model, product materials are viewed as “nutrients” that will be used again, as materials are either recycled into new materials or are composted and serve as inputs for the production of new materials and products.

This circular economy model also includes the important concepts of repair, reuse, refurbishment, and other means of enabling users to derive additional value from products and materials. By extending the lives of products, these models reduce waste and alleviate the need to extract or procure materials for the creation of new products to replace the products that are still in use. These models are fundamental components of the broader circular economy concept.

In addition, alternate product access models – such as rental, subscription, and resale – help enable circular product models. These models provide an alternative to the unidirectional, one-time transactions via which many products are sold in today’s economy. This commonplace product sales model implies that a product – and its component materials – are expected to become effectively valueless by the end of the product’s useful life. The consumer is then responsible for disposing of the product. Since the product and materials’ value is assumed to be zero, a landfill is often their final resting place.

The above-mentioned alternate access models can enable a different fate for products, where they can be utilized by more than one user during the products’ useful lives. The products are then more likely to be recycled, since these models often enable companies to collect the products from customers at end-of-life. Companies then have an incentive to maximize the return they derive from the products and their component materials by recycling them as a low-cost input to the manufacturing process, or perhaps by

selling them to a third-party that can utilize them as a valuable manufacturing input. This means that, under favorable circumstances, these alternate product access models can reduce waste, provide users with added value, and enable organizations to earn additional revenue or reduce costs.

Each of the stages of the value chain described above is an important component of a circular model. However, a primary focus of this report is the end-of-life stage, where a product reaches the end of its useful life. End-of-life is an important stage of the product's life. It is the point that determines whether the product's component materials are recycled and continue to add value to the system, or whether the value in those materials is lost when the product finds its way into a landfill. When this happens, those materials add no value and, as noted previously, may cause soil and groundwater contamination or other environmental harm.

Optimizing products and materials for end-of-life, however, requires many parties at various points in the value chain to act in a systematic manner, which can be complex and challenging. Products must be designed with materials that are recyclable or compostable. Products made of multiple materials (as most products are) must be designed for disassembly so materials can be separated for recycling or composting. In addition, there must be a means of collecting products from users at end-of-life and of getting their component materials to the point where they can be composted or recycled. Finally, infrastructure must exist to process the materials and compost or recycle them. All of this must be done in a manner that is cost-effective and that has a lower combined environmental impact than simply disposing of the product via conventional methods.

All of the factors described above contribute to the complexity of deploying circular product models. This report will explore many of these factors in additional depth.

b. What is a circular economy and where does existing research come from?

The concept of a circular economy came about as an alternative to traditional linear product models, in which resources and materials are extracted, used, and then disposed of. This traditional model is often referred to a “take, make, and dispose” model, and it is increasingly believed to be undesirable for

a variety of reasons (Ellen MacArthur Foundation, 2013). First, in a world with a growing population that consumes increasing quantities of resources, coupled with a finite supply of those resources, many fear this model will increasingly result in resource shortages. In addition, as resources become more scarce, more environmentally harmful steps are often necessary to extract them. Finally, from a strictly economic perspective, value is wasted when products and materials that could be recaptured and put to use in the economy are simply disposed of.

While there exists a body of academic research on this topic, much of the leading research has been created by industry-focused organizations. Two such prominent non-profit organizations include the Ellen MacArthur Foundation and the Cradle to Cradle Products Innovation Institute. Each of these organizations is described below.

Ellen MacArthur Foundation: Founded in 2010, the stated goal of the Ellen MacArthur Foundation is “accelerating the transition to the circular economy” (2017). The organization produces research on this topic in the form of learning guides, economic reports, case studies, and books. They also partner with leading businesses and organizations in this space to develop circular business initiatives.

Cradle to Cradle Products Innovation Institute: The Cradle to Cradle Products Innovation Institute was founded in 2010. Its focus is on scaling up the transformation to a circular economy by educating and empowering consumer product manufacturers. The organization administers the *Cradle to Cradle Certified™ Product Standard*, which is a public-facing certification that assesses products against criteria in the following categories: Material Health, Material Reutilization, Renewable Energy & Carbon Management, Water Stewardship, and Social Fairness (Cradle to Cradle Products Innovation Institute, 2018).

Additional research on this topic has been conducted by trade journals such as the *Journal of Industrial Ecology*, the *Journal of Cleaner Production*, and various academic institutions. The Journal of Cleaner Production defines the circular economy as:

“A regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling” (Geissdoerfer et al., 2017).

This definition of the circular economy is comprehensive and incorporates elements from definitions of the term from various academic institutions and the Ellen MacArthur Foundation. This is the definition that is used throughout this report.

The following is a summary of the essential components of a circular economy model for durable goods (Ellen MacArthur Foundation, 2013; Cradle to Cradle Products Innovation Institute, 2018).

- Designing products to enable a circular lifecycle

If a product is to achieve its optimal fate at end-of-life, it must be designed accordingly.

Depending on circumstances, this could mean:

- a. *Selecting materials that are recyclable and recycled.* This is beneficial because recycled materials typically have a smaller environmental footprint than virgin materials, and recyclable materials can be used multiple times – potentially indefinitely. This avoids the environmental impact and economic cost of extracting new materials.
- b. *Ensuring the product is disassemblable.* This helps to ensure the product’s component materials can be separated for recycling. It also enables easy product repair since it allows individual materials or components to be removed and repaired or replaced.

- c. *Optimizing the product to serve its intended purpose.* A product that does not serve its purpose effectively – regardless of whether it is effectively designed for recyclability at end-of-life – is not a viable alternative to another product that does.
- d. *Building durability into the product.* A product that is designed for a circular lifecycle but fails prematurely will contribute to undesirable environmental outcomes, as the product will likely then become waste, and a new product will need to be created to replace it.
- e. *Minimizing the environmental impact associated with the product's manufacture.*
Assessing products' lifecycle environmental impacts and designing and manufacturing products in a way that minimizes them is its own field of study, but it is an important concept that is related to the topic of circular economy (US EPA, 2017).

- Ensuring maximum value is derived from products

Keeping products in use helps to ensure as much value as possible is derived from products and avoids the impacts of having to manufacture new products to replace existing products. This involves product repair, maintenance, remanufacturing, refurbishing, and reuse. Product repair and proper maintenance keep products in a usable state for an extended period of time.

Remanufacturing and refurbishing restore products to a usable state. Reuse involves utilizing an existing product rather than a new product (Ellen MacArthur Foundation, 2013). Alternate product access models – beyond the common model where a product is sold to a consumer via a one-time transaction in which ownership transfers from the seller to the buyer – enable multiple users to extract value from a product during its useful life. This typically results in more value being derived from a product during its life and reduces the quantity of products needed to satisfy the demand of users. Examples of alternate product access models include product rentals, subscription, and the sale of used products.

- Optimizing the fate of a product and its component materials at end-of-life

The end of the product's useful life is the point at which the product is no longer usable and cannot be repaired, remanufactured, or refurbished. Optimizing the product's fate at this point

means utilizing the product and its component materials for the purposes where they provide the greatest economic value and where net environmental impact is minimized. Depending on the circumstances and materials, this may mean recycling or composting the product and/or its component materials.

c. *What are the benefits of a circular economy?*

The circular economy's potential environmental and economic benefits are many. Primary environmental benefits include (1) reduced resource consumption and increased resource productivity resulting from the decreased need for virgin material inputs and (2) reduced waste as products and materials are recycled or composted instead of disposed of in landfills. For these reasons and others, McKinsey & Company (2015) estimates that the transition to a circular economy in Europe alone would provide €1.8 trillion in economic benefits annually.

Beyond simply reducing resource consumption, a circular economy offers the promise of decoupling resource consumption from economic growth. This benefit is widely cited in the literature on this topic. Economic growth brings a higher standard of living and other benefits to human society. Under the existing model, however, it also requires consumption of a finite stock of resources and relies on manufacturing practices that degrade the environment. Many fear that the current model, if left unchanged, may eventually exhaust resource stocks. This brings into question the sustainability of the current model. The decoupling of economic growth from resource consumption via a shift to a circular economy offers the prospect of both removing future barriers to economic growth and reducing environmental impact associated with the production of goods.

Among the benefits of a circular economy is reduced impact to the environment associated with product manufacturing. In addition to requiring resource inputs, most – if not all – manufacturing practices currently impact the environment in a negative manner. Manufacturing the materials that compose products typically accounts for an outsize contribution to the product's overall environmental footprint (Kering, 2016). Since circular product models promote the recycling of materials and thus

reduce the need to manufacture new materials, they offer the prospect of significantly reducing a product's environmental impact. This includes reducing key impacts such as carbon emissions associated with product manufacture. As climate change becomes an increasingly dire issue, this benefit may become even more important.

A circular economy also offers potential benefits to human health, beyond those simply associated with reduced impact to the environment. A key component of design for end-of-life is accounting for “material health” (Cradle to Cradle Products Innovation Institute, 2018). This involves considering and avoiding the impacts to humans and other organisms associated with the chemical components of products and materials. These impacts include those posed to humans through direct use of a product as well as those associated with exposure to soil, water, and air that may be contaminated during manufacturing or after disposal of products or materials.

The circular economy concept also offers many benefits to businesses and the economy. Though the primary focus of this report is not on the economic benefits of circular models, when assessing adoption of circular models by businesses, it is important to understand the incentives and implications for businesses considering the adoption of such models.

One key benefit of a circular economy is reduced waste, as materials and products are kept in use for an extended period of time. Waste causes environmental challenges and also results in economic loss. Managing waste has an economic cost, and materials and products that enter landfills prematurely represent missed opportunities to extract value and reap the full return on the investment that went into the manufacturing process. McKinsey projects that adopting circular economy principles in Europe could boost resource productivity by up to 3% annually and result in €1.8 trillion in annual economic benefits, largely for the reasons described above (McKinsey & Company, 2016).

In addition, a circular economy reduces resource risk and mitigates price and supply volatility in key commodities and resources. Key manufacturing inputs – including energy, water, and raw materials – are in increasingly high demand, and various factors can cause fluctuations in price and supply. Businesses that rely on more efficient circular models – which offer the prospect of using less of these

inputs on a per-unit basis – mitigate risk and business impacts caused by fluctuations in these factors (Ellen MacArthur Foundation, 2013).

Finally, a circular economy could support the development of alternative business models that provide businesses with opportunities for increased revenue and profitability and stronger relationships with customers. As businesses begin to develop capabilities to recycle products in a cost-effective manner, it may become more feasible and financially beneficial for companies to reclaim products at end-of-life. Traditionally, it may have been assumed that at end-of-life a product has a lower value than the cost required to recycle the product. In an ideal circular model, however, the value of the product and its component materials can potentially be reclaimed via an economically net-positive process.

The prospect of recapturing value from products at end-of-life has benefits beyond simply reclaiming the value of products and materials. This model also facilitates longer-term and potentially more profitable relationships with customers. Where a product may traditionally have been sold to a customer via a one-time transaction, a circular model where a product is returned at end-of-life to the company that provided it offers the potential for leasing, rental, subscription, and other alternative product access models. These models may involve ongoing interaction with customers, more consistent revenue streams, and the ability to better service customers and maintain their business over an extended period of time.

d. What are the challenges and potential downsides of a circular economy?

A key challenge that is documented in the literature on the circular economy is the degree to which the existing economic system must shift in order to bring about this new model. The current economic system is largely built on the linear (“take, make, and dispose”) model. Products generally are not designed for recycling at end-of-life, and infrastructure does not currently exist to facilitate the recycling of most products on a large scale. This presents significant challenges to a large-scale transition to a circular economy, and such a transition is likely to be slow and require the investment of significant resources and effort.

Many logistical challenges also stand in the way of the transition to a circular economy. Even if products are composed of recyclable materials, for example, existing product supply chains do not include a scalable means of collecting products from consumers at end-of-life, disassembling them to separate their component materials, and transporting those materials to a location where they can be recycled. Further, transporting products and materials has an environmental impact that may offset some of the environmental benefit associated with recycling the materials.

In addition, most existing large-scale materials recovery facilities (MRF) that provide broad geographic coverage and can accommodate significant volumes of materials are largely designed to process product packaging made of specific materials and of certain shapes and sizes. This means they are unable to process at scale the vast majority of products on the market. While facilities may exist that recycle many – or even most – materials, many of these facilities exist only in certain locations and can process limited volumes of materials. Collecting, sorting, and transporting materials to these locations can be logistically challenging, and the recycling process itself may be prohibitively expensive (Lave et al., 2008).

The recycling process for many materials can also result in the degradation of those materials. While certain materials – including glass and many metals such as steel – can be recycled virtually endlessly, other materials such as paper and many types of plastic degrade over multiple recycling phases and must be combined with virgin materials to maintain quality (Glass Packaging Institute, 2018; Graedel et al., 2011; Ellen MacArthur Foundation, 2016).

Given these challenges, it is estimated that only 9.1% of global materials are currently “cycled”, or returned as material inputs to the manufacturing process at end-of-life, as opposed to being disposed of (de Wit et al., 2018). This indicates there is significant room for improvement in rates of recycling of materials, and illustrates that the global economic system, for the most part, is currently not operating as a circular model.

e. What are some examples of circular product models that are relevant to the outdoor industry?

Examples of products that fully embody a circular economy are difficult to find. The [Analysis of Case Studies](#) section of this report, however, explores examples of outdoor hard goods products that demonstrate various components of a circular economy model at end-of-life.

At the same time, examples of products that exhibit many – but not all – components of a circular product model do exist. The Dutch retailer C&A recently launched the world’s first Cradle to Cradle Certified™ T-shirt line. The product is composed of all-natural, compostable cotton, including the thread used to sew the garment and the care labels (both of which are often made of non-compostable synthetic materials). The product’s chemical inputs, including dyes and printing inks for care labels, are screened and approved to ensure they do not pose a threat to the environment when the product is composted at end-of life (Makower, 2017).

Another example is the line of recyclable denim products recently launched as part of a partnership between the iconic denim company Levi Strauss & Co. and the sustainability-focused menswear brand Outerknown (Outerknown Journey, 2017). Some product in the line are made entirely of recyclable polyester, including fabrics, trims, buttons, and snaps. Other products in the line are made of cotton, with trims that are meant to be easily removable from the garment to enable the cotton to be recycled. It is not clear *how* the cotton is meant to be recycled, however. (Levi’s also announced in 2016 its partnership with Evrnu, a company that is developing a process to chemically recycle cotton into virgin-quality yarns (Levi Strauss & Co., 2016). Perhaps technologies such as Evrnu’s will one day enable Levi’s cotton products to be chemically recycled on a large scale.)

In addition, there are numerous examples of compelling new models to enable repair, reuse, and refurbishment of products to keep those products in use for longer and enable users to extract additional value from them. One such example is the Renewal Workshop, a company that partners with apparel brands such as prAna and Mountain Khakis to “renew” discarded clothing (The Renewal Workshop, 2018). This involves cleaning and repairing the clothing as needed in their factory near Portland, OR. The

renewed clothing is then offered for sale to customers. The renewed products are adorned with a patch that signifies they have been renewed the Renewal Workshop and serves as a small fashion statement by customers.

Another emerging model is exemplified by Yerdle, a technology company that partners with brands such as Patagonia, Eileen Fisher, and REI Co-op to resell products (Yerdle, 2017). Yerdle's model enables these companies to sell their customers used items, many of which might otherwise have been discarded. By enabling products to be purchased and utilized by a new owner, Yerdle keeps products in use and reduces the need for users to buy new products. In addition, Yerdle's model enables companies to earn additional revenue by selling products that traditionally may have been written off as unsalable. This model also enables consumers to buy used products that are often sold at a lower price point than comparable new products.

The Cradle to Cradle Products Innovation Institute maintains a database of products that are certified to the Cradle to Cradle standard (Cradle to Cradle Products Innovation Institute, 2018). While none of the certified products come from the outdoor industry, there are many certified office furniture products. Many of these products are made of materials that are used widely in outdoor products, such as plastic, aluminum, and polyester. The certified products are designed for disassembly so that the individual materials can be separated and recycled, in addition to meeting the standard's other criteria related to Material Health, Renewable Energy & Carbon Management, Water Stewardship, and Social Fairness.

Finally, in recent years, some companies have begun to offer product take-back options in order to collect products from their customers at end-of-life. Some companies, such as Apple, collect products directly from customers for resale, refurbishment, or recycling (Apple Inc., 2018). In the case of recycling, it is unclear what portion of products' component materials are recycled, and via what means. Other companies partner with third-party service providers such as I:CO (which handles apparel and footwear) or TerraCycle (which handles "hard-to-recycle materials") (I:Collect GmbH, 2018; TerraCycle, 2018). Both companies offer examples of their success in processing products at end-of-life for resale,

recycling, or reuse in another format. It is unclear what portion of products and materials get processed via each of these means, and the extent to which each outcome supports a reduced environmental impact. In addition, there is the potential that takeback models such as these provide a perverse incentive for customers by encouraging them to retire products prematurely and upgrade to new ones. Each of these models, however, provides a glimpse into what product take-back can look like and allows other companies an example they can reference as they explore options for product take-back.

III. MATERIALS AND METHODS

As part of this research project, a series of exploratory product case studies were conducted to assess the extent to which companies that make hard goods for use in the outdoor industry have successfully deployed circular product models. This case study research method was selected primarily because case studies offered an opportunity to gather in-depth insights into this nuanced topic.

According to Robert K. Yin's *Case Study Research (1994)*, case studies are an appropriate method when a research product investigates a "contemporary phenomenon within its real-life context" and when "the boundaries between phenomenon and its context are not clearly evident." Both of these descriptions apply to the deployment of circular product models by the companies featured in this report. It was identified prior to commencing the case studies that each company interviewed would be operating in a unique environment, where various financial, strategic, and cultural factors would contribute to the way they conceptualize and pursue circular product models. Case studies would allow the opportunity to not only identify the extent to which the companies had deployed circular product models, but also to explore the complex set of factors that contributed to their approach. Finally, the manageable sample size – seven products – ensured that conducting case studies was logistically feasible. Because this research features multiple case studies and explores various factors and indicators of deployment of circular models, it is considered to be a *multiple case* and *multiple unit of analysis* study.

Use of case studies as a research method does also have disadvantages. In this report, the primary disadvantage relates to the relatively small sample size of seven companies. While the information gathered from these companies provides valuable insights into how they have approached the development of circular product models, these insights cannot necessarily be extrapolated to represent general trends within the broader realm of business. In addition, the information gathered from interview participants cannot be assumed to be true and must be validated for accuracy, though this is not unique to case study research.

Representatives³ from the companies highlighted in this report were interviewed and asked questions about their efforts to deploy circular models, their success in doing so, and the challenges they encountered that inhibited full deployment of these models. Interviews were also conducted with organizations that handle or study product and material waste to understand the extent to which recyclers were currently capable of enabling the recycling of the products and materials. Interview questions are outlined in [Appendix 1](#).

Products were selected based on their having one or more characteristics that either currently exemplify one or more components of a circular product model or that position the product well for the development of such a model. See [Appendix 2](#) for a description of the characteristics of each product.

The first six case studies that appear in the following section assess products that have already deployed one or more components of a circular product model. The final case study – which features the REI Co-op Flexlite Chair – is a feasibility assessment that identifies likely barriers, challenges, and opportunities for that product if the company were to explore means of adopting various components of a circular product model for that product.

IV. ANALYSIS OF CASE STUDIES

³ See [Appendix 3](#) for a list of individuals interviewed for this report.

This section outlines the key findings from the interviews with the companies whose product(s) exemplify one or more components of a circular product model.

i. [Manduka Recycled Foam Yoga Block Set](#)

Background & Progress To Date

- Manduka did not have a formal circular economy strategy in place or a separate team that manages sustainability, but environmental responsibility was reported to be embedded in the company's culture and to be part of the product development team's overall set of objectives. It was noted that Manduka is working towards formalizing and expanding their sustainability practices within the next 1-2 years.
- The Manduka design team has pursued the use of recycled materials in their products. The Recycled Foam Yoga Block Set is made from a single material: ethylene-vinyl acetate (EVA) foam. 50-75% of the foam is pre- and/or post-consumer recycled content.
- Though EVA foam is not commonly recycled, it is recyclable in some instances⁴, and Manduka has tested the feasibility of offering a recycling option for products such as yoga mats. To date, this recycling model has not been deployed at scale.
- Manduka's use of recycled materials in key products was reported to be a successful initiative, as customers and employees have responded positively to it.

Barriers & Challenges

- Challenges in collecting products from customer at end-of-life, coupled with degradation of the quality of the foam during recycling, have thus far made it infeasible to develop a scalable model for product take-back and recycling.
- The cost of recycled materials was identified as a barrier, as recycled EVA can be more expensive than virgin EVA.

⁴ See INTCO Recycling, 2015

ii. [Stanley eCycle Infinite Mug/Bowl Set](#)

Background & Progress To Date

- While Stanley does not have a formal circular economy strategy in place, sustainability was reported to be an important focus for the company, and they have thoroughly explored the various components of circular product models to determine whether and how they might be integrated into the company's operating model.
- A key component of Stanley's approach was the development of the proprietary eCycle polypropylene material, which is made of recycled materials and is recyclable via curbside programs in some markets⁵.
- The Infinite Mug/Bowl Set was made using eCycle polypropylene and was specifically designed to be recyclable. Its size and shape also make it the only product from the case studies that may be compatible with existing materials recovery facilities (MRF), which are designed to process plastic waste and packaging (including cups) of similar size and shape.

Barriers & Challenges

- A key challenge for Stanley is finding recycled input materials that meet the requirements set forth by the U.S. Food and Drug Administration (FDA) for products meant to come in contact with food and beverages. It was reported to be very difficult to find recycled materials – especially post-consumer materials – that meet these requirements.
- Ensuring the purity of materials in the recycling process was reported to be challenging, since the materials can only be recycled a finite number of times (approximately ten, according to the interview) before they are degraded beyond usability.
- Polypropylene is not accepted in all MRFs, so the recyclability of this product varies by region. It was reported that Stanley will pay for customers to ship some Stanley products for recycling at end-of-life if recycling is not an option in their region.

⁵ See American Chemistry Council, 2018

- The cost of recycled materials has intermittently been a challenge, as their price relative to virgin materials has fluctuated.
- Consistency of supply was also noted to be a challenge, as demand for recycled materials has at times outstripped supply.

iii. *Niche Theme Snowboard*

Background & Progress To Date

- Niche Snowboards does not have a formal circular economy strategy in place, but they cited the desire to make more sustainable products as a primary reason the company was founded.
- The Theme snowboard is specifically designed for recyclability. The vast majority of the various materials from which it is composed were reported to be recyclable, and some of them contain recycled content. The materials are bonded together using a “bio resin” that can be dissolved to allow for disassembly and separation of the materials at end-of-life. The product has other design features intended to reduce its overall environmental impact, including its use of recycled components and lower-impact materials such as flax fiber in place of carbon fiber.
- The Theme snowboard utilizes recycled materials for its base, sidewalls, and edges. It was reported that this, along with the use of the bio resin (a waste product), reduces the product’s environmental footprint.
- While the Theme snowboard was designed for disassembly and recyclability, Niche only recently launched the product, and the products that have been sold into the marketplace had not yet begun to reach end-of-life.
- Though the Theme snowboard is not yet being recycled, the recyclability of the materials was reported to have enabled the company to eliminate waste from the manufacturing process, as all scrap materials are recovered and re-utilized within the manufacturing process or recycled.
- The Theme snowboard is the only one of Niche’s six snowboard models currently designed for recyclability, but they have established a goal of having all their models designed for disassembly

in the future. For the 2018-2019 season, three of their models will be designed for disassembly and recyclability.

- Niche is in the process of establishing a model for product take-back to collect the snowboards for recycling.
- Niche's circular product strategy has been deemed a success, due to its financial feasibility, positive perception by customers, and their belief that it will enable their company to reduce its environmental footprint and help set an example that others in the industry can follow.

Barriers & Challenges

- Infrastructure does not yet exist for recycling many of the product's component materials. Overcoming this barrier may involve a combination of (a) partnering with waste management companies to find and develop ways to recycle specific materials and (b) identifying other ways to "upcycle" waste materials, such as using waste resin to create skateboard decks or other products.
- Collecting products from customers at end-of-life is expected to be a challenge, as snowboards are difficult to ship due to their relatively large size and weight. Customers will likely have to be incentivized in some way to ship or transport the boards back to Niche or a third-party for recycling.
- There is one small rubber component in the Theme snowboard that is not currently recyclable.

iv. [Timbuk2 Bags](#)

Background & Progress To Date

- Timbuk2 does not have a formal circular economy strategy in place; rather they have an aspirational goal of sending zero waste to landfills.
- Timbuk2 has focused largely on improving the end-of-life outcomes for the products they sell by offering repair services (for a small fee), selling replacement components, and providing guidance to customers on how to conduct basic repairs.

- Some of Timbuk2's products contain recycled polyester fabric as main body fabric or liner fabric.
- They have explored options for recycling their products and component materials at end-of-life but have not yet found a scalable recycling solution.
- The company has partnerships with organizations such as the YMCA, At the Crossroads, and Youth Care, to which they donate usable bags at end-of-life.

Barriers & Challenges

- Timbuk2's bags are made of a multitude of materials, which makes it difficult to separate and recycle each material.
- A partnership with a third-party organization that recycles the products was canceled due to limitations in recycling options that could accommodate the multitude of materials contained in many of Timbuk2's products.
- The company has explore various design improvements to improve their products' fate at end-of-life, but they have not yet found a scalable way of designing their products for disassembly and recycling.
- They have utilized recycled input materials in the past, but the cost of recycled materials was found to be significantly higher than that of virgin materials, and it proved to be a barrier to scaling the use of recycled materials broadly across their product offering.

v. [Yakima Skybox Carbonite Cargo Boxes](#)

Background & Progress To Date

- Yakima does not have a formal circular economy strategy in place, but environmental sustainability was reported to be an important emphasis for the company in its overall operations.
- Yakima has developed a "design guide" for the company's engineers that, among other things, provides guidance on how sustainability-related considerations should be accounted for in the product design process. The design guide also specifies that, whenever possible, products should

be designed to include replaceable parts. The company also stocks and sells replacement parts to its customers.

- The company's Skybox Carbonite cargo boxes are composed almost entirely of ABS plastic and can be disassembled relatively easily. As a result, Yakima is able to send the ABS components from some damaged products (where reuse or resale to a consumer is not an option) back to their supplier for recycling.
- To keep the quality of the recycled materials consistent, Yakima's supplier for these cargo boxes maintains a semi-closed loop process, whereby they convert materials they receive from Yakima back into plastic to be used by Yakima. Through this process, Yakima is able to utilize in their products ABS plastic that contains up to 80% recycled content.
- By collecting and providing ABS components from damaged products, along with manufacturing scraps, back to their supplier, Yakima is able to save on raw material costs.
- Overall, Yakima's use of recycled ABS plastic in their Skybox Carbonite cargo boxes has been deemed a success, as the materials have performed well, helped keep costs down, and been received well by their customers.

Barriers & Challenges

- Yakima's biggest challenge in deploying a circular product model for their cargo boxes is collecting them from customers at end-of-life. The cargo boxes are large, voluminous, and heavy. The Skybox 21 Carbonite model, for example, is over seven feet long, occupies 21 cubic feet of volume, and weighs over 60 pounds. Transporting this product for collection would be expensive and inefficient and would likely result in significant carbon emissions depending on the type of vehicle used for transportation.
- Controlling for quality when using recycled materials can be challenging. Even when partnering with their supplier to utilize a semi-closed loop process, at least 20% virgin plastic must be used to maintain performance standards for the output material. The company has had even more

significant challenges with material quality when purchasing recycled materials on the open market.

- Limits in the supply of recycled ABS plastic has been a challenge, as there are not always sufficient quantities available to meet the market's demand.
- While many of Yakima's other products are made of highly recyclable materials, such as plastics, steel, and aluminum, they have not made significant progress in facilitating the recycling of the materials due to the complexity of their products that leads to challenges in disassembly.

vi. *Almond Surfboards & Designs R-Series Surfboard*

Background & Progress To Date

- Almond does not have a formal circular economy strategy in place, and they were not familiar with the term 'circular economy', though they were very aware of the environmental impacts associated with the surfboard manufacturing process. Their efforts to use recyclable materials in their surfboards stems from their desire to improve the end-of-life outcomes for their products and reduce waste throughout the product lifecycle.
- The R-Series Surfboard - which will launch in the Spring of 2018 - will be made primarily of Expanded Polystyrene (EPS) foam, which is recyclable via a partnership with the company's material supplier.
- The board will be labeled with the following guidance to customers: "Do not sent to landfill. Return to manufacturer for recycling."
- After the boards are disassembled at end-of-life at the local collection facility, the foam will be ground up, compressed, and shipped to the manufacturing facility for recycling.
- Because these boards have not yet launched, the company has yet to collect any boards from their customers at end-of-life. The use of recyclable EPS, however, will greatly reduce waste in the manufacturing process, as production scraps can be utilized back into the process.

- Financial feasibility, performance, and reduced environmental impact were identified as primary factors that were used to justify Almond’s use of this new material and manufacturing technique for their surfboards.

Barriers & Challenges

- Collecting the boards from customers, especially customers who do not live near the company’s Southern California headquarters, is expected to be a challenge.
- Disassembling the boards may prove to be a challenge, though they are made of only a handful of components. These components include: the surfboard itself, the fins and fin box (which can be made of various materials, some of which may be recyclable), and a traction pad made of EVA foam. Not all of these materials are readily recyclable, though some of them are durable enough to be reused.
- As the EPS foam is recycled, it must be combined with approximately 75% virgin EPS to maintain the performance required for the surfboards.

vii. *Feasibility Assessment: REI Co-op Flexlite Chair*

As noted in the Materials & Methods section, this case study is a feasibility assessment that identifies likely barriers, challenges, and opportunities for the REI Co-op Flexlite Chair if the company were to explore means of adopting components of a circular product model for the product.

The Flexlite Chair is a relatively complex product, made from a variety of materials - including a nylon seat, aluminum frame, and various components made from other materials including polypropylene, EVA foam, and elastic. The nylon seat fabric is coated in polyurethane (PU) and has a durable water repellent (DWR) finish. These coatings promotes structural stability of the fabric and enhances durability by protecting it from the elements. The product is designed to be partially disassemblable so that the chair can be made more compact for storage. However, even in its most disassembled state, many of the chair’s components are permanently or semi-permanently affixed to one another, making the product difficult to disassemble – especially by a consumer – for recycling. The

product's designers optimize the chair's design to achieve the best combination of minimal weight and maximum strength and comfort, while managing cost to ensure financial viability. Design changes that significantly diminish any of these parameters are not palatable.

In exploring potential design changes to this product to bring about a more circular product lifecycle, product designers were asked to consider the following options in order to assess their feasibility and identify potential challenges or barriers:

- Utilizing recycled input materials, particularly recycled nylon and aluminum, the chair's two primary components by weight. This was reported to be a relatively simple task, however the two primary potential challenges are cost and material performance. The cost of recycled materials can be significant higher than that of virgin materials, and this must be weighed against the environmental benefits of utilizing recycled materials. (The cost of recycled fabric for the seat were up to 60% higher – a significant premium – relative to the non-recycled alternative.) In addition, in some instances the strength and durability of recycled materials was noted to be inferior to that of their virgin counterparts. While most of the recycled materials met the specifications set forth for this product, in some instances doing so would require the use of a heavier weight material. Overall, improvements in the recycling process for both polyester and nylon have made both materials viable alternatives to their virgin counterparts in most applications, though cost considerations can be significant.
- Removing materials that may inhibit recycling, such as the EVA foam and polypropylene tape. This presents a challenge, but these materials could potentially be removed via a redesign and/or substitution with a different material. For example, the EVA foam currently provides cushioning to the user of the chair, but this could potentially be replaced by thicker fabric in these places or by slightly modifying the geometry of the chair to reduce pressure points in these areas. The

polypropylene tape could potentially be removed or replaced by tape made from a form of polyester or nylon (which could be selected to be consistent with the seat material).

- Utilizing a single recyclable material, such as polyester or nylon, for all components of the seat.

Utilizing a single recyclable material, such as nylon or polyester, for all components of the seat can be challenging in the event that other materials that have been utilized provide a specific benefit, whether it be strength, reduced weight or cost, performance features, or a particular aesthetic. In the case of the Flexlite Chair, however, it may be possible to select a single material for each of the various fabrics that comprise the seat without sacrificing on any of these parameters. The main challenge, however, is that the seat fabric is coated in PU and DWR, which reduces its recyclability, as each can contaminate the recycling stream and thus prevent the fabric from being feasibly recycled.

- Designing the chair's frame for easy disassembly by a consumer, so that the frame's primary component – aluminum – can be recycled. Designing the product for disassembly can be a challenge for many products, though the Flexlite Chair has always been designed for partial disassembly in order to make it more compact and packable for users. The primary design changes that would make the chair more disassemblable are to provide the end user a way of easily removing the plastic feet from the aluminum legs and of removing the elastic cord that runs through the aluminum frame. If the company were to adopt these features, however, it would be critical that neither of these changes compromise the durability of the chair or result in accidental disassembly during the period of customer use.

In order to recycle the Flexlite Chair, REI would likely also have to deploy a product take-back initiative to collect products from customers at end-of-life. While this may be feasible, it could create the perverse incentive for customers to prematurely retire products that are still fully functional. This would

likely be a net-negative outcome in terms of environmental impact, as it may result in the initial environmental impact of manufacturing the product being amortized over a decreased lifespan. If the customer were to upgrade to a new chair after retiring their old chair, the environmental impact associated with manufacturing of the new chair should also be considered. Under such a model, in order to minimize environmental impact, it would be essential to attempt to keep the original chair in use, perhaps by enabling its sale to another customer. Overall, however, for the chair to be retired prematurely and recycled or disposed of would be a perverse and undesirable outcome in terms of its environmental impact.

Summary of Findings from Product Case Studies

The following is a summary of how the company representatives interviewed for this report responded to the questions they were asked during the interviews.

1. Do the companies have in place a formal product sustainability strategy aimed at improving the sustainability of the products they sell?
 - All of the companies had a sustainability strategy in place to some degree, though some were more formal than others.
 - Only two of the seven companies (28.6%) had dedicated sustainability staff in place whose primary responsibility was to elevate sustainability practices within the organization.
 - The most common initiative that the companies were pursuing that contributed to a circular product model was the use of recycled materials in products.
2. Prior to being contacted for participation in this research project, how familiar were the company representatives with the “circular economy” concept?
 - The majority of the company representatives - six out of seven (85.7%) – were familiar with the term “circular economy”.

3. Do the companies have a formal “circular economy” strategy that integrates each of the factors that contribute to a circular product model into their product design process and/or customer engagement model?
 - None of the companies had a formal circular economy strategy in place, though several were informally pursuing key components of circular product models.
4. What progress have the companies made to date in deploying circular product models?
 - The most common progress made by the companies was the use of recycled materials in their products. Five of the seven products (71.4%) contained recycled materials.
 - Each of the products contained at least some materials that were recyclable.
 - None of the products were currently being recycled at a large scale, though three of the seven (42.9%) had demonstrated the feasibility of recycling at least the majority of the materials in the product and that recycling takes place at a small scale.
 - Four of the seven products (57.1%) had been shown to be fully disassemble or did not need to be because they were only composed of one material.
 - Two of the seven products (28.6%) were specifically designed to be disassemblable.
 - None of the companies had a product take-back model in place that allowed the company to collect products from customers at end-of life.
 - The companies varied in the extent to which they provide guidance to their customers on how to recycle or dispose of these products, with some providing no guidance and others providing basic guidance on the product itself, on physical marketing materials, or online. It is unclear the extent to which the guidance provided by the companies is effective and clear to customers.

The following table summarizes the progress made by the companies in deploying circular product models:

<u><i>Indicators of Progress in Deploying Circular Product Models</i></u>	<u><i>Number of Companies or Products that Demonstrated Indicator (Out of 7 Total Case Studies)</i></u>
Company had dedicated sustainability staff in place	2 (28.6%)
Company representative familiar with term “circular economy”	6 (85.7%)
Company had formal circular economy strategy in place	0
Product contained recycled materials	5 (71.4%)
Product designed to be disassembled	4 (57.1%)
Product demonstrated to be recyclable	3 (42.9%)
Company offered product take-back at end-of-life	0
Product currently being recycled at a large scale	0

5. For the products in question, what were the companies’ measures of success, and did the product meet those measures?
 - The most common measures of success were cost, performance, and product sales. It was stated by most of the companies that reduced environmental impact was a key impetus for integrating components of circular product models into the products, but none of the companies had a robust means of measuring the reduction in environmental impact.

6. What barriers have the companies encountered that have hindered the roll-out of a broader "circular economy" strategy or the advancement of individual components of circular product models?
 - The most common barriers – identified by each (100%) of the companies – were the lack of infrastructure for (a) collecting products at end-of life and separating and sorting component materials and (b) recycling products’ component materials.
 - Six of the companies (85.7%) identified as a challenge the inability to recycle individual component materials contained within the product.
 - Four of the companies (57.1%) identified the increased cost of recycled materials relative to virgin materials as a challenge.

- Four of the companies (57.1%) identified as a challenge the complexity of the product and the resulting inability to disassemble it into its component materials.
- Two of the companies (28.6%) identified as a challenge the lack of availability of recycled materials that would meet the specifications of the product.
- Two of the companies (28.6%) identified the inferior quality of recycled materials as a challenge.
- Awareness of designers was not noted to be a challenge for any of the companies, likely because (a) designers are becoming increasingly aware of the circular economy concept and (b) it is lack of prioritization rather than designer awareness that typically cause a company not to prioritize the development of circular product models.
- Consumer awareness of recycling options was not noted to be a challenge for any of the companies, likely because the recycling options available for them to be aware of are limited.
- Economic, financial, or logistical challenges in the recycling process were not reported by any of the companies, likely because these recycling processes have not yet been developed to the point where those types of challenges could be specifically identified.

The following chart summarizes the key barriers or challenges identified and the number of companies that identified them:

<u>Barrier / Challenge</u>	<u>Number of Companies that Specifically Cited Barrier / Challenge</u>
Product and/or materials collection infrastructure	7 (100%)
Infrastructure for recycling or composting materials	7 (100%)
Recyclability of individual materials	6 (85.7%)
Cost of recycled materials	4 (57.1%)
Complexity of products / lack of ability to disassemble products	4 (57.1%)
Availability of recycled materials	2 (28.6%)

Quality of recycled materials	2 (28.6%)
Awareness of materials developers and product designers	0
Consumer awareness of product recycling options	0
Economic or financial challenges in the recycling process	0
Logistical challenges in the recycling process	0

Summary of Findings from Interviews with Organizations that Handle or Study Waste

A number of key findings emerged in the interviews conducted as part of this project with representatives⁶ from various organizations that handle or conduct research on waste. These findings are summarized below.

1. A product's function must not be compromised to facilitate recycling. All else equal, designing a product to be recyclable is clearly beneficial. However, if in doing so the product's function is compromised to the point where it no longer effectively serves its purpose, recyclability becomes irrelevant. In such a scenario, the product's utility has been decreased, and it likely no longer serves as a viable choice for a consumer. A consumer will likely choose to purchase another product that better meets their needs, independent of whether it is recyclable.
2. Materials selection is a key means of promoting the recyclability of products. While various factors contribute to whether a product gets recycled, perhaps none are more important than the initial selection of materials that are used to make the product. If the materials selected for use in the product are not recyclable, none of the other design features meant to promote recyclability will be effective. In addition, some materials are technically recyclable but not practically recyclable, due to lack of infrastructure or technical limitations. It is ideal to select materials that are highly recyclable in many regions and which can be recycled over and over with minimal degradation in material quality.

⁶ See [Appendix 3](#) for a list of individuals interviewed for this report.

3. Purity of material inputs to the recycling process is a significant factor. Similar to the point above, it was noted in many of the interviews that ensuring the purity of material inputs to the recycling process is a challenge. In addition to the technical limitations of current recycling processes described above, lack of a reliable means of labeling and identifying materials currently makes managing the input stream to the recycling process very challenging. While recent initiatives such as the How2Recycle logo have demonstrated the feasibility of such a model for packaging, research for this project did not identify any scalable models that exists for the labeling of products themselves and their component materials (GreenBlue, 2018). Even in the realm of packaging there exists significant opportunity for the improvement of material selection for recycling. A significant benefit of the How2Recycle logo, for example, is its ability not just to label which materials are recyclable, but also to label which are not. This prevents contamination of the recycling stream. Ultimately, labeling of this sort will likely be needed to increase the purity of inputs to the material recycling process, and such labeling has yet to be developed for most consumer goods and materials.
4. Under current technology, materials often degrade over multiple rounds of recycling. For the products included in the case studies that were made from recycled materials – including the Almond R-Series Surfboard, Manduka Recycled Foam Yoga Block, and Yakima Skybox Cargo Boxes – it was noted that the recycled materials must be combined with some amount of virgin materials during the recycling process to maintain performance. This is generally due to the current state of recycling technology and infrastructure, the fact that a small amount of impurity or contamination in a recycling stream can significantly degrade the quality of the output material, and challenges associated with collecting materials that are pure and free from contamination (Hopewell et al., 2009). However, certain materials types – such as steel and glass – can currently be recycled virtually endlessly with minimal degradation in quality. As infrastructure for collecting and recycling other materials improves, it is likely that both recycling

rates and the feasibility of using a higher portion of recycled content in products will significantly increase.

5. Keeping a product in use for as long as possible is preferable to recycling the product. Since much of a product's lifetime environmental impact stems from its manufacture, maximizing the duration of the product's life ensures its embedded environmental impact is amortized over a greater useful life. It can also be assumed that the product's continued use reduces or eliminates the need for other products to be manufactured to replace it. Thus, under most circumstances, it is environmentally preferable to keep a product in use than to recycle it. However, the relative environmental impact of keeping a product in use compared to recycling should be considered to determine which is the better option.
6. Improved recycling technology and infrastructure will increase the feasibility of recycling materials and products. As noted above, current recycling technology often requires a high degree of purity in the input materials to a recycling process. While this will continue to be a constraint – and efforts should be taken by product designers and materials collectors to enable the collection of pure materials at end-of-life – recycling technologies are likely to improve to better accommodate a broader range of input materials and to be less inhibited by the presence of impurities or contaminants (Lv et al., 2015). However, improvements in technology should not be viewed as a “silver bullet” that will in isolation enable drastic improvements in recycling rates. Thus, other actors throughout the value chain should continue to do their part to enable product recycling while monitoring the latest recycling technologies to ensure they are designing products for an optimal fate at end-of-life. The Closed Loop Fund – an organization that pools funds from investors and organizations and whose objective is “scaling recycling infrastructure and sustainable manufacturing technologies that advance the circular economy” – is a compelling example of an organization that is working to help build out more robust recycling infrastructure (Closed Loop Partners, 2017).

7. “Anything is recyclable”, but whether a market exists for a material determines if it will be recycled. Many of the individuals interviewed for this project stated that “anything is recyclable.” While that may not literally be true, their point was that it is technically possible to recycle most materials. As a result, the key factor that determines whether a material gets recycled is whether a market exists for that material (i.e., whether the material can feasibly be recycled in such a way that the benefits outweigh the costs). If it does, that provides the incentive for recycling infrastructure to be developed. It also incentivizes individuals and organizations to recycle the materials rather than simply disposing of them, which may be the more convenient option.
8. Bringing about a circular economy requires changes throughout the value chain. In much of the existing literature on this topics and in interviews conducted for this project, there were many references to the need for a “systems approach” to transition to a circular economy (Ellen MacArthur Foundation, 2013). This means that a circular model cannot be brought about by addressing any one component of the value chain (e.g., product design, manufacturing, consumer use, product take-back, recycling/disposal, etc.) in isolation. At the same time, it is virtually impossible for all of these value chain components to be addressed cohesively and simultaneously, especially by an individual organization. As a result, there may not be a smooth transition to a circular model across each component of the value chain simultaneously. In many of the interviews with brands and recyclers, individuals encountered a *chicken vs. egg* dilemma. For example, a product can be designed to be recyclable, but there may not be recycling infrastructure in place that can recycle the product’s components. Or a recycler could install recycling infrastructure for a given material, but products are not currently being designed in such a way that the materials can be separated for recycling in the first place. Thus, it is recommended that individual actors within various segments of the value chain make progress within their segment to the extent that it is feasible. For example, a product designer should design products for recyclability if it is feasible, even if infrastructure to recycle the product or its component materials does not currently exist. Similarly, recyclers should consider building out their

recycling capabilities for additional materials in collaboration with customers in order to better accommodate the recycling of existing materials and to prepare for the recycling of common materials in the future. In each of these scenarios, strategic thought and consideration of likely future scenarios are required.

8. *Economic factors are important in enabling product recycling.* In instances in the case studies where materials were currently being recycled, economic factors made it financially appealing for the recycling to take place; in other words, utilizing the recycled materials was more affordable than procuring virgin materials. While many companies place significant weight on environmental benefits, large-scale material recycling and use of recycled materials is not likely to expand significantly until these actions become financially beneficial.
9. *Regulatory factors are important in enabling product recycling.* Many companies cited as a significant factor the 2017 actions taken by the Chinese government to place stricter requirements on the purity of materials imported into the country for recycling (de Freytas-Tamura, 2018). Many countries have traditionally sent much of their recyclable waste – including paper, plastic, and metals – to China for recycling. China’s move, intended to reduce the pollution associated with the recycling of the materials, significantly reduces the viability of sending waste from developed countries, such as the U.S., to China for recycling. This has made it so that many materials that would have previously been shipped to China for recycling may now be disposed of in landfills. It will take time for the full implications of this development to become evident, but it illustrates the extent to which regulatory factors impact the recycling of products. In addition, regulations such as those related to extended producer responsibility (EPR) were cited as potential means of encouraging product recycling and product design to enable it. EPR requires that “producers” – as opposed to municipalities – take responsibility for the disposal (or, at least, the cost of disposal) of products (Lifset et al., 2013). This provides an incentive for companies to design products in a way that reduces cost at end-of-life and increases the potential for products and materials to be recycled. EPR laws have been implemented in countries around

the world – including the U.S. – though they cover more product categories and are more commonplace in regions including the European Union (E.U.), Canada, and Japan (Product Stewardship Institute, 2016; OECD, 2014). Expanded coverage of EPR laws – both geographically and in the scope of covered product categories – could increase the rate of product recycling.

Summary of Key Opportunities to Increase Portion of Products that are Recycled

In assessing the insights gleaned from all the information gathered as part of this project, the following key opportunities emerged for companies to expand the deployment of circular product models and increase the portion of products that are recycled.

- Assess current material usage across product offering to identify key opportunities. Companies should assess the types and volumes of materials being used across their product offering to better understand the environmental impacts associated with each, the extent to which recycled input materials can be used, and whether the materials are recyclable. When possible, companies should identify opportunities to substitute recycled and recyclable materials for the key materials identified. In addition, some products – such as those that are more disassemblable and contain higher volumes of individual materials – may present the most feasible opportunities to develop circular product models.
- Consider “circular economy” principles in the product design process. Before making any changes to a product’s design to promote a circular product lifecycle, designers should be sure they do not compromise the product’s durability or its ability to serve its intended purpose. As noted previously, products that are recyclable but fail prematurely or do not perform effectively are not viable alternatives to non-recyclable products that perform better. While maintaining function, performance, and durability, however, designers should consider exploring opportunities to integrate the following features into the product design process:

- *Use of recycled materials*: Recycled materials typically have a lower environmental impact than virgin materials, and using recycled materials in products helps to “close the loop” so that recyclable materials are utilized as inputs to the manufacturing process.
- *Design for recyclability*: Incorporating design strategies that promote recyclability is critical to ensuring can be recycled. Specifically, this means designers should:
 - Use materials that are widely recyclable.
 - Avoiding design features that compromise recyclability. While in some instances design features inevitably impact recyclability, when possible, design features such as coatings or accessories that may inhibit recycling should be avoided.
- *Design for disassembly*: Ensuring the product can be disassembled into its distinct component materials ensures that individual materials can be separated for recycling.
- *Design for consistency of materials*: This makes it so that less disassembly is needed to separate the product into its component materials, and it results in greater volumes of a smaller number of materials, which makes recycling more feasible.
- *Labeling of materials for recyclability*: Labeling individual materials so the customer or waste handler can identify them and whether they are recyclable helps ensure the product’s component materials can be sorted and processed appropriately.
- *Explore opportunities to derive maximum value from products and keep them in use*. Regardless of the feasibility of recycling a product, keeping products in use for an extended period of time typically supports positive environmental outcomes, as it reduces the need to create new products. In addition, customers are typically pleased when they can use their products for an extended period of time. Companies can keep products in use through many of the means mentioned in this report – including repair and reuse – and potentially through alternate product access models such as product rental and leasing and the sale of used products.
- *Partner with waste management organizations to optimize disposal of products*. Developing strong relationships with organizations that handle product waste can be helpful in optimizing the

fate of products at end-of-life. Through open communication and collaboration, these organizations can provide guidance on how to design products to promote recycling, and whether any operational or logistical steps should be taken to promote responsible handling or disposal of products at end-of-life. These relationships can also help waste management organizations understand and prepare for the type of waste that they can expect based on the types of products being designed (and, importantly, how they are packaged). Over the long-term, communication between waste management organizations and companies designing products can help the waste management companies develop infrastructure for product recycling. And in the short-term, these organizations can collaborate to recycle or responsibly dispose of key high-volume products.

V. CONCLUSION

This research project was intended to identify the extent to which circular product models have been deployed within the outdoor industry for hard goods. It was also intended to identify key barriers and challenges encountered by companies seeking to deploy such models. Finally, its objective was to identify opportunities to overcome these barriers and further deploy circular models across the industry.

Because the circular economy concept is still relatively new, and a transition to circular product models requires significant change throughout the value chain, examples of circular product models are still relatively scarce. The research conducted for this project profiled one segment (hard goods) of one industry (the outdoor industry), but it captured a compelling snapshot of what it may look like for an industry to transition to a more circular economy. The companies highlighted in this report are among the group of pioneers that are exploring various ways of deploying one or more components of a circular product model. The product case studies demonstrated that various organizations are approaching this challenge and opportunity in different ways, and no company has yet fully exemplified the model. While none of these companies have yet realized a fully circular product model – where the products are made entirely from recycled materials, are fully recyclable, and are actively being recycled – the progress they

have made should not be underestimated. These models will likely evolve into and inform more comprehensive models in the future, both within these organizations and across the industry.

This report also identified numerous barriers that make the transition to a more circular economy challenging. Many of these challenges were specific, including the fact that most products are not designed for end-of-life and that infrastructure and technology do not currently exist to facilitate recycling of most products at scale. The macro challenge that was observed is that a large-scale transition to a more circular economy requires significant change by a large number of parties throughout the value chain. Companies are beginning to identify and address these challenges, however. It will remain to be seen whether more circular product models begin to appear organically across industries as companies become convinced of the merits of these models, or whether legislation or other mechanisms will be needed to bring them about.

In order to further advance the deployment of circular product models, companies will need to explore opportunities to address the specific barriers – some of which are outlined in this report – that currently stand in their way. Progress may take time, but it is recommended that companies begin to explore how they might integrate components of circular product models into how they operate. There is a wide variety of different approaches that may be appropriate for different companies based on their distinct operating model.

This report also identified the need for additional research in various areas. One key area is the current state of recycling technologies and infrastructure for common materials used in many products, such as nylon, polyester, and various types of hard plastics and metals. Additional research in this area will help to identify the circumstances under which these materials can be feasibly recycled. For example, it was unclear whether a polyester fabric must be made of 100% polyester to be recycled, and whether and to what extent the presence of other materials (such as a fabric coating or finish, or other blended fibers) diminishes recyclability. A clear understanding of the extent to which these factors inhibit material recycling will be highly valuable for product and materials designers seeking to select the best materials for use in products while optimizing for end-of-life.

Additionally, there is an opportunity to more thoroughly explore the environmental benefits of circular product models as compared to more conventional product models. A thorough understanding of the environmental benefits of circular models could help companies optimize their overall business models to most effectively reduce environmental impact while maximizing financial opportunities presented by circular models. For example, it will be valuable for companies to understand the net environmental impact of operating product take-back models to collect products from customers at end-of-life, which potentially presents the opportunity to provide them with a new product at that time. This model provides an economic benefit, but it is unclear the extent to which it provides an environmental benefit. As a result, additional research is needed in this area.

Finally, additional research into the factors that drive the often increased cost of recycled materials would be valuable. In this report, it became clear that in some instances recycled materials are more affordable than their non-recycled alternatives, while in other instances they are more expensive. In instances when the materials are more expensive, the increased cost was often cited as a significant barrier to overcome that inhibited companies from using recycled materials. Identifying the factors that contribute to the cost of the recycled materials – such as the supply of input materials, demand for the recycled materials, relative cost of alternative materials, etc. – can help companies address and mitigate those factors in order to help secure recycled input materials at affordable prices.

Overall, though the broader “circular economy” is in its infancy, it is a promising model that is beginning to be realized across the outdoor industry and beyond.

Appendix 1: Interview Questions Asked of Company Representatives

1. Does your company have in place a formal product sustainability strategy aimed at improving the sustainability of the products you sell? (Y/N)
 - a. If yes, does your strategy formally include an emphasis on any of the following building blocks of a circular product model (indicate all that apply and describe):

Use of recycled materials	Designing products for disassembly
Use of recyclable materials	Product take-back for recycling
Use of compostable materials	Guidance to consumers regarding how to recycle products

2. Prior to being contacted for this interview, how familiar were you with the “circular economy” concept? (not familiar / somewhat familiar / very familiar) Please describe your level of familiarity and the extent to which “circular economy” principles play into your role within your company, if at all.
3. Does your company have a formal “circular economy” strategy that integrates each of the factors in question 1.a into your product design process and/or customer engagement model?
 - a. If yes, please describe.
 - b. If no, please describe whether it was a formal decision not to pursue a circular economy strategy.
4. What progress has your company made to date in deploying circular product models? Please describe, and (if available) indicate how your company is tracking against the following metrics or other metrics identified by your company to measure your progress.

Approximate % of products using recycled materials	Approximate % of products that can be feasibly recycled at the end of their useful life
Approximate % of products that use recyclable or compostable materials	Other (please describe)

5. For the product in question...
 - a. What metrics are used to determine whether the product was a success?
 - b. Did the product’s use of one or more of the circular building blocks listed above contribute to positive performance against these metrics?
 - c. Was the use of the circular building blocks deemed to be a success?
 - d. Is your company likely to expand the use of these circular building blocks for other products?
6. What barriers has your brand encountered that have hindered the roll-out of a broader "circular economy" strategy or the advancement of the individual initiatives that support the factors listed in question 1.a? (Please select from the below and describe.)

i.

Availability of recyclable/compostable materials	Awareness of materials developers and product designers	Infrastructure for recycling or composting materials
Cost of recyclable/compostable materials	Recyclability or compostability of materials	Economic or financial challenges in the recycling process
Quality of recyclable/compostable materials	Consumer awareness of product recycling or composting options	Logistical challenges in the recycling process
Complexity of products / lack of ability to disassemble products	Product and/or materials collection infrastructure	Other (please describe)

Appendix 2: Overview of Products Included in Case Studies

<i><u>Brand</u></i>	<i><u>Product</u></i>	<i><u>Product Complexity</u></i> ^{*7}	<i><u>Primary Material(s)</u></i>	<i><u>Product Size</u></i> [*]	<i><u>Product Categorization</u></i> [*]	<i><u>Disassemblable?</u></i> [*]	<i><u>Individual materials recyclable?</u></i> [*]	<i><u>Contains recycled content?</u></i> [*]	<i><u>Is product currently being recycled?</u></i> [*]
Manduka	Recycled Foam Yoga Block	Low	Ethylene-vinyl acetate (EVA) Foam	Small	Hard	N/A (single material)	Yes	Yes	No
Stanley	eCycle Infinite Mug/Bowl Set	Low	Polypropylene/silicone	Small	Hard	N/A (single material)	Yes	Yes	Unclear
Niche	Theme Snowboard	High	Various	Large	Hard	Yes	Yes	Yes	Partially
Timbuk2	Bags (Various)	High	Various	Medium	Hybrid	No	Yes	Some	No
Yakima	Skybox 21 Carbonite	Medium	Acrylonitrile-Butadiene-Styrene (ABS) plastic	Large	Hard	Yes	Yes	Yes	Partially
Almond Surfboards & Designs	Recyclable surfboard	Medium	Expanded polystyrene (EPS) foam	Large	Hard	Partially	Yes	No	No
REI Co-op	Flexlite Chair	High	Aluminum, Nylon	Medium	Hybrid	Partially	Yes	No	No

*See definitions of key product descriptors on the following page.

Appendix 2: Overview of Products Included in Case Studies (continued)

The following are definitions of select product descriptors included in the chart on the previous page:

Product Complexity

- Low: Product composed of a single material
- Medium: Product composed of five or fewer materials and/or product contains only one primary material
- High: Product composed of many (five or more) materials

Product Size

- Small: Product small enough to be held in the hand of an average person indefinitely
- Medium: Product too large for an average person to hold in their hand indefinitely, but small enough to be conveniently transported by an average person without the assistance of a powered vehicle
- Large: Product difficult to transport significant distances without the assistance of a powered vehicle

Product Categorization

- Hard: Product composed primarily or exclusively of hard materials
- Soft: Product composed primarily or exclusively of soft materials
- Hybrid: Product composed of both hard and soft materials

Disassemblable?

- Yes: Product designed to be separated into each individual component material at end-of-life
- Partially: Product designed so some – but not all – component materials can be separated at end-of-life
- No: Product not designed so materials can be separated at end-of-life
- N/A (single material): Product composed of a single material, so disassembly is not necessary

Individual materials recyclable?

- Yes: One or more of the product's primary component materials can technically be recycled
- No: None of the product's primary components can technically be recycled

Contains recycled content?

- Yes: Product contains one or more primary materials that are composed of recycled content
- No: Product contains no primary materials that are composed of recycled content

Is product currently being recycled?

- Yes: Each of the product's components is currently being recycled in 60% or more of the markets in which it is sold
- Partially: Company provided evidence that some of the product's components are currently being recycled in some instances
- Unclear: Some or all of the product's components may be recycled in some instances, but company did not have evidence of this
- No: None of the product's components are currently being recycled

Appendix 3: Interview Participants

Companies

- Almond Surfboards & Designs | Dave Allee, Founder
- Manduka | Lizzie Harper, Materials Specialist
- PMI (owner of Stanley) | Valerie Bone, Director of Corporate Responsibility
- Niche Snowboards | Ana Van Pelt, Co-Founder / Chief Creative Officer
- Timbuk2 | Ariel Raymon, Corporate Sales Account Manager
- Yakima | Emily Davis, Director of Operations
- REI Co-op | Jon Arruda, Gear Designer

Waste Management Companies

- Recology | Quinn Apuzzo, Waste Zero Manager
- The Renewal Workshop | Nicole Bassett, Co-founder
- Waste Management | Raymond Randall, Managing Principal – Technology, Innovation and Strategic Alliances

Organizations that Conduct Research

- Cradle 2 Cradle | Stacy Glass, Vice President, Built Environment
- deBrand | Wes Baker, Director of Environment & Innovation
- Oregon Department of Environmental Quality | David Allaway, Senior Policy Analyst

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