Nature Action 100

Ceres

Exploring Nature Impacts and Dependencies

A Field Guide to Eight Key Sectors

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Exploring Nature Impacts and Dependencies: A Field Guide to Eight Key Sectors

Exploring Nature Impacts and Dependencies: A Field Guide to Eight Key Sectors was developed by the sustainability nonprofit Ceres on behalf of Nature Action 100.

About Nature Action 100

Nature Action 100 is a global investor engagement initiative focused on driving greater corporate ambition and action to reduce nature and biodiversity loss. Investors participating in the initiative engage companies in key sectors that are deemed to be systemically important in reversing nature and biodiversity loss by 2030. For more information, visit natureaction100.org.

About Ceres

Ceres is a nonprofit organization working with the most influential capital market leaders to solve the world's greatest sustainability challenges. Through our powerful networks and global collaborations of investors, companies, and nonprofits, we drive action and inspire equitable market-based and policy solutions throughout the economy to build a just and sustainable future. For more information, visit ceres.org and follow @CeresNews.

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Introduction

Urgent action is needed to halt and reverse nature loss. Nature and biodiversity support all systems of life on Earth. Nature is not only fundamental to human well-being but also to humanity's economic stability and development.

With more than half of the world's GDP highly or moderately dependent on nature, nature loss creates significant risks for companies and investors. Companies across the economy are exposed to extensive physical risk because they depend on nature for valuable resources, such as wood, water, and agricultural products, as well as crucial ecosystem services such as pollination and regulation of water flows. Yet many companies are exacerbating these risks by degrading the ecosystems where they operate or source raw materials, driving changes in land-, water-, and ocean-use, resource exploitation, climate change, pollution, and the spread of invasive species.

Companies that fail to address their impacts on nature also face increasing transition risk in the form of pressure from regulators and other stakeholders. For example, the European Union's Corporate Sustainability Reporting Directive (CSRD) has extensive requirements for corporate disclosure of biodiversity and nature impacts. Under the EU's Corporate Sustainability Due Diligence Directive (CSDDD), companies |will also need to report their business-wide plans for reducing ecosystem degradation. During the past year, the Taskforce for Nature-related Financial Disclosures (TNFD) released recommendations for companies to voluntarily disclose nature-related dependencies, impacts, risks, and opportunities. While more than 320 global companies and financial institutions—representing $4 trillion in market capitalization—have signed on to adopt the TNFD recommendations, most companies are not prepared to address the challenge.

Business as usual will only continue to accelerate an already alarming rate of nature loss.

- More than one million species are at threat of extinction—many in the coming decade.
- 75% of land has been significantly altered.
- 66% of oceans are experiencing negative impacts.
- 87% of wetland areas have been destroyed.
- Indigenous Peoples, who protect 80% of the world's biodiversity in forests, deserts, grasslands, and marine environments, are increasingly under threat.
- Nature plays a key role in addressing climate change. Protecting and restoring forests and other natural ecosystems could deliver as much as a third of the climate mitigation needed to limit global temperature rise in line with the Paris Agreement.

This guide provides a framework for investors to understand how businesses impact and depend on nature so that they can begin engaging with companies in their portfolios on nature. Nature impacts and dependencies vary from sector to sector and even from company to company, creating different levels of risk exposure for companies. Investors can reduce portfolio risk by engaging with companies on nature impacts and dependencies.

- The factsheets highlight impacts and dependencies for the eight priority sectors of Nature Action 100, a global investor engagement initiative focused on driving greater corporate ambition and action to reverse nature and biodiversity loss.
- The key sectors deemed systemically important in reversing nature and biodiversity loss include biotechnology and pharmaceuticals, chemicals, consumer goods retail, food, food and beverage retail, forestry and packaging, household and personal products, and metals and mining.
- Each factsheet describes primary activities associated with the sector, nature-related impacts and dependencies of those activities, and questions for company engagements.
- Ceres' Global Assessment of Private Sector Impacts on Water describes impacts and dependencies on water for the biotechnology and pharmaceuticals, chemicals, food, forestry and packaging, and metals and mining sectors.

Investors interested in engaging portfolio companies on nature can take action through Nature Action 100. To date, more than 200 institutional investors—representing over $28 trillion in assets under management and advice—are participating to engage on nature and biodiversity loss. Investors interested in engagement and resources on water can participate in the Valuing Water Finance Initiative.

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A Key to the Field Guide

The eight Nature Action 100 sectors at the foundation of these factsheets follow SASB's Sustainable Industry Classification System®(SICS®). However, impact and dependency data sources utilize other classification systems. For example, the ENCORE tool uses the Global Industry Classification Standard (GICS) while the Science Based Target Network's (SBTN) Materiality Screening Tool uses the UN's International Standard Industrial Classification of All Economic Activities (ISIC). The resulting factsheets therefore cross-index classification systems with SICS sectors at the core. For example, the Chemicals Sector factsheet references GICS-defined sub-industries: commodity chemicals, diversified chemicals, fertilizers and agricultural chemicals, industrial gases, and specialty chemicals.

Sector Overview

A general sector description and a diagram of typical production stages and processes. Some companies occupy multiple stages in a sector.

Sector Breakdown

A list of nature-relevant activities in companies' direct operations, selected for their significant (medium, high, or very high materiality in ENCORE) impacts and dependencies, as well as example companies.

Nature-Related Impacts

A summary of the material nature-related impacts across direct company operations. Given that companies are responsible for addressing nature across their entire supply chains, companies will need to consider the impacts of upstream and downstream activities. For example, upstream impacts for companies in the Food and Beverage Retail Sector are captured in the Food Sector factsheet.

The impact categories, based on ENCORE, include air pollution, disturbances to nature, freshwater ecosystem use, greenhouse gas (GHG) emissions, land use, ocean use, other natural resource use, soil pollution, solid waste, water pollution, and water use. Factsheets only include medium to very high materiality impacts.

Nature-Related Dependencies

A summary of the material nature-related dependencies across direct company operations. Only direct dependencies with medium to very high materiality are included. Companies should be aware of additional nature-related dependencies across their value chains (upstream and downstream). Ecosystem services are listed following ENCORE dependency categories directly. For sectors with extensive nature-related dependencies, such as the Food Sector, dependencies are condensed into a broader grouping of ecosystem services: enabling services, mitigating services, protecting services, provisioning services. These services are further described where relevant.

Key Questions for Investor Engagement

A selection of questions designed to facilitate investor engagement on nature with companies in each sector.

Related Resources

Additional materials that investors can utilize to advance their understanding of a sector, its nature-related impacts and dependencies, and its potential for engagement

Biotechnology and Pharmaceuticals Sector

Sector Overview

Biotechnology and pharmaceutical companies share similar product lines and industry interconnections—pharmaceutical companies often buy and scale biotechnology discoveries. However, their distinct approaches to product development set biotechnology and pharmaceutical companies apart. Biotechnology companies research, develop, and produce various commercial products, including vaccines, plastics, biofuels, and genetically modified organisms, by altering the function of living organisms such as yeast, crops, and bacteria. In comparison, pharmaceutical companies use chemical and synthetic processes to create medicines, often relying on nature for bioactive compounds and genetic diversity.

The impacts and dependencies described in the following sections focus on the direct operations of biotechnology and pharmaceutical companies. However, companies must consider the impacts and dependencies of upstream (raw material sourcing) and downstream (transportation, distribution, and application or use of products) activities.

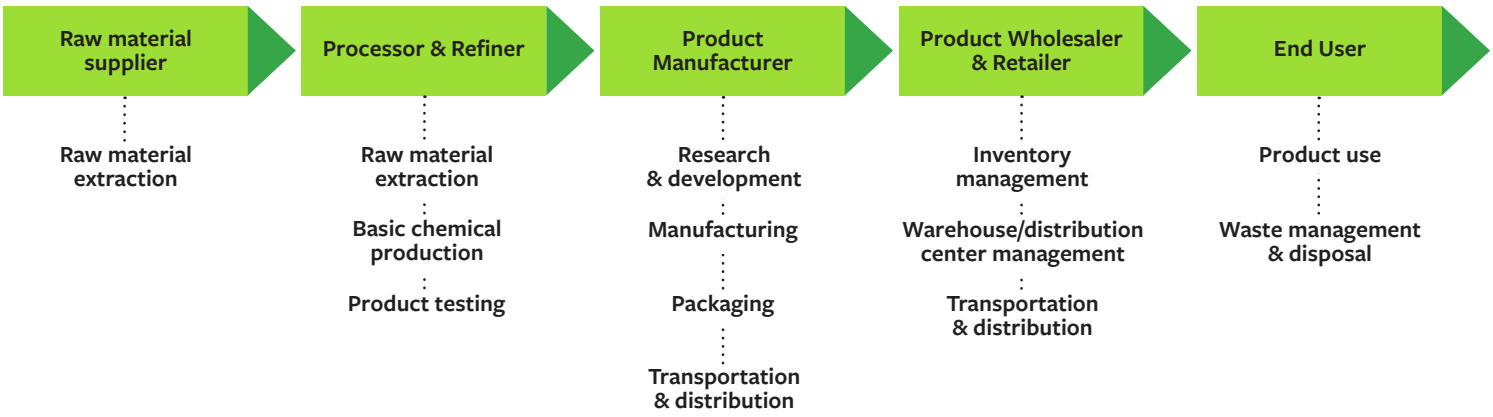

Figure 1. Value chain for the biotechnology and pharmaceuticals sector. Biotechnology and pharmaceutical companies may occupy multiple stages, typically processor/refiner and product manufacturer.

Sector Breakdown

Biotechnology

- **Activities:** The key nature-relevant activities for biotechnology companies include: 1) sourcing biological materials (microorganisms or tissues, cells, or genes of plant or animal origin); 2) processing and refining materials for use in research and development (product testing); 3) manufacturing (including packaging); and 4) final use and disposal.
- **Example Companies:** Amgen Inc., Biogen Inc., BioNTech, CRISPR Therapeutics AG, Gilead Sciences Inc., Illumina, Moderna, Regeneron Pharmaceuticals, Takeda Pharmaceutical Co. Ltd., and Vertex Pharmaceuticals.

Pharmaceuticals

- **Activities:** Key nature-relevant activities for pharmaceutical companies include: 1) sourcing biological materials for research and development; 2) processing and refining materials for research and development (product testing); 3) manufacturing (and packaging) final products; and 4) final use and disposal.
- **Example companies:** Abbott Laboratories, AstraZeneca plc, Bayer AG, Eli Lilly and Co, GSK plc, Johnson & Johnson, Merck & Co, Inc, Novartis AG, Pfizer Inc, Roche Holding AG, and Sanofi.

Nature-Related Impacts

Impact Category	Biotechnology	Pharmaceuticals
Air Pollution	M	M
Soil Pollution	H	H
Solid Waste	H	H
Water Pollution	H	VH

Figure 2. Material nature-related impacts across the direct operations of the biotechnology and pharmaceuticals sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE and Global Assessment for Private Sector Impacts on Water.

Air, Soil, and Water Pollution

In their production processes, biotechnology and pharmaceutical companies use chemicals, such as acetone, benzyl chloride, and hydrochloric acid, that can contribute to environmental pollution if not handled properly. For example, the wastewater and other liquid wastes discharged by manufacturing facilities may contaminate nearby soil and surface, ground, and drinking water with heavy metals and nutrients known to produce dead zones and harmful algal blooms. Active pharmaceutical ingredients designed to resist breakdown in the human body can also enter natural ecosystems through household wastewater that is regularly released into rivers, lakes, and oceans, adversely affecting aquatic ecosystems and wildlife. Drug residues may increase the spread of antibiotic-resistant bacteria and cause reproductive and developmental issues among fish and amphibians.

Solid Waste

The production processes and waste disposal practices of biotechnology and pharmaceutical companies can produce biowaste that creates biosafety hazards for humans and the environment—especially aquatic ecosystems. Packaging may also contribute to environmental pollution if not disposed of properly. In the pharmaceutical sector, many existing packaging systems, including blister packaging, create significant amounts of waste. In addition, billions of dollars of medications are thrown away unused each year.

Nature-Related Dependencies

Dependency Category	Biotechnology	Pharmaceuticals
Genetic Materials	M	M
Water Resources	H	H

Figure 3. Material nature-related dependencies across the direct operations of the biotechnology and pharmaceuticals sectors. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE.

Genetic Materials

Biotechnology and pharmaceutical companies often rely on genetic diversity in wild flora and fauna for research and development. Eighty percent of registered medicines used to treat illnesses ranging from Alzheimer's, cancer, malaria, and Parkinson's are derived from or inspired by natural products. Resource overexploitation, habitat loss, and biodiversity decline can limit access to valuable genetic materials for applications like genetic engineering.

Indigenous peoples and local communities are vital partners in sourcing materials, given their depth of traditional biodiversity knowledge and stewardship of land. When sourcing genetic materials, the biotechnology and pharmaceutical sector must respect the rights of Indigenous Peoples and local communities who may steward the land. Companies also need to respect traditional knowledge about the properties of particular plants, animals, and chemical compounds and have a system in place to compensate communities for that knowledge. This is outlined in the Nagoya Protocol, an international agreement intended to promote the fair and equitable sharing of benefits arising from the use of genetic resources and associated traditional knowledge.

Water Resources

Biotechnology and pharmaceutical companies require significant quantities of high-quality water for their development and manufacturing processes. This high demand for limited, ultra-pure water sources can lead to such impacts as the depletion of ground and surface water and disruption of the natural water cycle.

Key Questions for Investor Engagement

- Has the company assessed material impacts and/or dependencies, including upstream and downstream in the value chain?
- What steps has the company taken to mitigate air, soil, and water pollution from the chemicals used in research and development and production processes?
- What steps has the company taken to properly manage biowaste and chemical waste?
- Given the company's dependence on genetic material, has the company incorporated biodiversity expertise, environmental analysis, and environmental risk assessments into its strategy and structure?
- What is the company's approach to engaging Indigenous Peoples and local communities as key stakeholders in the procurement of plants and animal species for biotechnical or pharmaceutical
- use? What policies or procedures are in place (such as the Nagoya Protocol) to ensure equitable sharing of benefits from drug discoveries?

For water-related engagement questions, investors can refer to Ceres' Valuing Water Finance Initiative.

Related Resources

- Ceres: Global Assessment of Private Sector Impacts on Water (Valuing Water Finance Initiative)
- Secretariat of the Convention on Biological Diversity: Bioscience at a Crossroads: Access and Benefit Sharing in a Time of Scientific, Technological and Industry Change

Chemicals Sector

Sector Overview

The chemicals sector creates over 70,000 products that are ubiquitous in modern life. Companies can be divided into five categories: commodity chemicals, including petrochemicals, plastics, and synthetic fibers; diversified chemicals, including any chemical products not otherwise classified; fertilizer and agricultural chemicals, including fertilizers, pesticides, and potash; industrial gases, including argon for welding, carbon dioxide for beverages, and nitrogen for refrigeration; and specialty chemicals, including specialty adhesives, food additives, and fragrances. Raw materials are used to prepare key chemicals that may be sold or used to produce additional compounds, which can, in turn, be formulated and fabricated into other products.

The sector heavily relies on natural resources for raw materials while significantly contributing to environmental and human health issues through the release of harmful pollutants into the air, water, and soils during the production and use of its products.

The impacts and dependencies described in the sections that follow focus on the direct operations of chemicals companies. However, companies must consider the impacts and dependencies of upstream (raw material sourcing) and downstream (transportation, distribution, and application or use of products) activities.

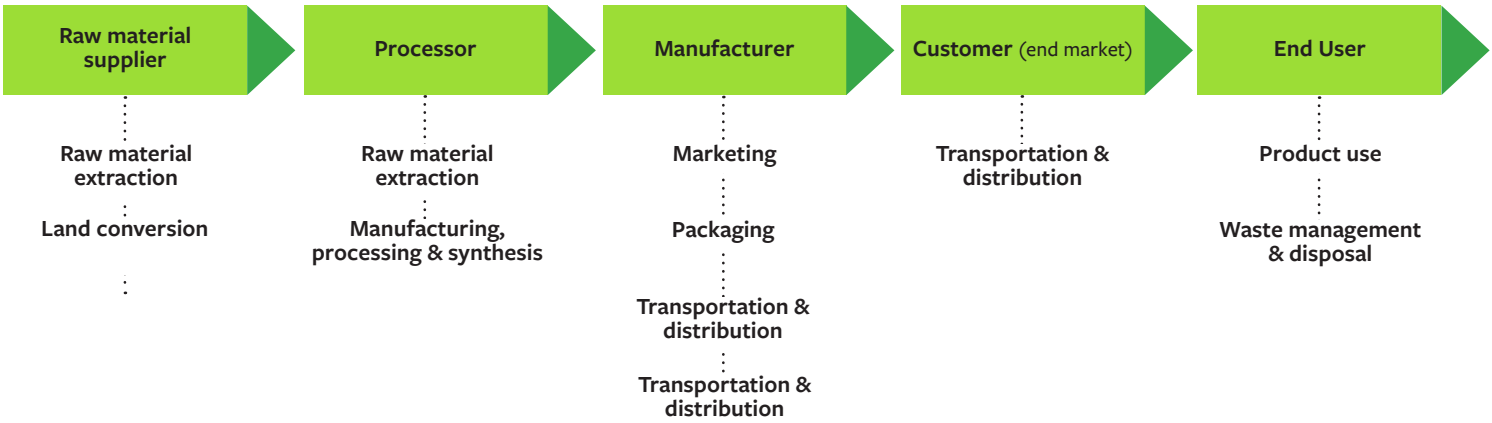

Figure 4. Value chain for the chemicals sector. Chemicals companies may occupy multiple stages, from raw material supplier to manufacturer.

Sector Breakdown

Activities

Due to their similar raw material inputs and manufacturing processes, key nature-relevant activities for all chemical companies include materials sourcing and production. Some chemical companies have specific activities with significant impacts and dependencies on nature, which include:

- Commodity chemicals: catalytic cracking (process for breaking large hydrocarbons into smaller molecules), fractional distillation, and crystallization (chemical separation and purification processes).
- Diversified chemicals: polymerization (creation of larger molecules from individual molecules) and vulcanization (chemical treatment of rubber to improve elasticity, strength, and stability).

- Fertilizer and agricultural chemicals: product application and use.
- Industrial gases: cryogenic air separation (process for separating air into its component gases), gas absorption (purification process), natural gas combustion, and recovery and separation of carbon dioxide.
- Specialty chemicals: catalytic cracking, fractional distillation, crystallization, solids processing (separation of solid matter from liquids, gases, and other types of solids), specialty product application and use.

Example companies

- **Commodity chemicals**: BASF SE, Dow Inc, and LyondellBasell Industries NV.
- **Diversified chemicals:** Ecolab Inc., H.B. Fuller Company, and Huntsman Corporation.
- **Fertilizer and agriculture chemicals**: CF Industries Holdings, Inc, The Mosaic Company and Yara International ASA.
- **Industrial gas**: Airgas, L'Air Liquide SA, Air Products and Chemicals, Inc, and Linde plc.
- **Specialty chemical**: Clariant AG, DuPont de Nemours, Inc, and Lonza Group AG.

Nature-Related Impacts

Impact Category	Commodity Chemicals	Diversified Chemicals	Fertilizer and Agricultural Chemicals	Industrial Gases	Specialty Chemicals
Air Pollution	H	M	H	H	H
Disturbances				H	
GHG Emissions	H	H		H	
Land Use	H	H		H	H
Soil Pollution	H	M	H	H	H
Solid Waste	H	M		H	H
Water Pollution	VH	VH		VH	VH
Water Use	M	M	M	M	M

Figure 5. Material nature-related impacts across the direct operations of the chemicals sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE and Global Assessment for Private Sector Impacts on Water.

Air Pollution

Various activities across the chemicals sector release air pollutants. For example, catalytic cracking produces emissions such as particulate matter, volatile organic compounds, nitrogen oxides, and sulfur dioxide. Incomplete combustion processes from industrial burners, boilers, or incinerators can generate emissions, including nitrogen oxides, carbon monoxide, sulfur dioxide, and particulate matter. In particular, sulfur and nitrogen emissions affect the ability of ecosystems to function and grow and adversely affect human health.

- **Fertilizer and Agriculture Chemicals:** Fertilizers release nitrous oxide, a potent greenhouse gas, as well as ammonia gas, an irritant that can have severe effects on human health, into the atmosphere after application. Pesticides also contribute to air pollution.
- **Industrial Gases:** During natural gas combustion, gaseous emissions of harmful substances, such as hydrogen sulfide, ammonia, and phosphine, may be released.
- **Specialty Chemicals:** Many products containing specialty chemicals, including adhesives, cleaning agents, paints, and personal care products, emit volatile organic compounds (VOCs) when used, contribute to the formation of ozone, a major component of smog, and particulate matter, which negatively impact human health and the environment.

Disturbances

Vibrations from heavy machinery, used for cryogenic air separation and carbon dioxide recovery and separation during industrial gas production, create noise pollution which can have profound impacts on wildlife and humans.

GHG Emissions

The chemicals sector is the world's largest industrial energy consumer and one of the largest emitters of carbon dioxide due to the use of carbon-intensive fuels as raw materials and energy sources. In 2022, primary chemical production released 935 million tons of carbon dioxide globally. The majority of these emissions come from the production of ammonia (45%)— primarily to manufacture fertilizer—methanol (28%), and high-value chemicals (27%) like ethylene, propylene, and benzene.

Land Use

The sector uses a large amount of raw materials to produce chemicals. Growing bio-based feedstocks for commodity chemicals, including corn, palm oil, sugarcane, and soy, can lead to ecosystem conversion for agricultural land. Fertilizers and specialty chemicals rely on mined, sometimes rare, raw materials. Extracting and producing these materials (including rare earth minerals) can drive land use change and habitat fragmentation. Mined phosphate and potash are key fertilizer ingredients, but phosphorous stores are quickly becoming depleted, threatening the availability of a key agricultural input.

Soil Pollution

Chemical manufacturing activities often generate significant quantities of waste that cause soil pollution if not managed in an environmentally sound manner. Similarly, as downstream companies use chemicals to manufacture goods, they may release dangerous substances that can accumulate in soils.

Fertilizer and pesticide application can also pollute soils by elevating nitrate, phosphorous, and heavy metal (cadmium) concentrations. Cadmium is linked to harmful health effects such as renal toxicity and osteoporosis. By polluting soils, fertilizer and pesticide overuse destroys the land farming relies on.

Solid Waste

The chemicals sector generates many different types of waste, most of which are highly hazardous chemical waste. Most solid chemical waste is metallic waste, which can leach into surrounding land when dumped in landfills or improperly disposed. Improper handling and management of chemical waste can degrade human health or environmental conditions.

Water Pollution

Water pollution impacts occur when effluents, wastewater, or other materials—including toxic chemicals and heavy metals—are released into nearby bodies of water. This may happen during initial manufacturing activities, transportation, or as downstream companies use chemicals in their products. Improper management, disposal, or release of waste materials, including any byproducts of or unused chemicals from manufacturing, may also cause water pollution. Contaminated water sources may have far-reaching consequences for aquatic ecosystems and human health.

Runoff from fertilizer and other agrochemical applications may adversely impact aquatic ecosystems. Nitrogen and phosphorus pollution has particularly devastating impacts on waterbodies, generating harmful algal blooms and aquatic dead zones. As pesticides enter our waterways, they also threaten aquatic plants, animals, and biodiversity.

Water Use

Several manufacturing-related activities rely heavily on water for cooling, chemical reactions, and solvent extraction. Advanced treatment technologies may be required to recycle water, depending on the specific chemicals and processes used and the resulting water quality. High water consumption in this sector can strain local water resources.

Nature-Related Dependencies

Dependency Category	Commodity Chemicals	Diversified Chemicals	Fertilizers and Agricultural Chemicals	Industrial Gases	Specialty Chemicals
Flood and Storm Protection	M		M	M	M
Water Resources	H			H	H

Figure 6. Material nature-related dependencies across the direct operations of the chemicals sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE.

Flood and Storm Protection

The facilities and infrastructure of industrial sites may be vulnerable to flooding and storms—which are increasing in intensity and frequency with global temperature rise—that could disrupt manufacturing processes, including catalytic cracking, cryogenic air separation, crystallization, fractional distillation, gas adsorption, solids processing, and synthetic fertilizer production.

Water Resources

Several of the sector's production processes heavily rely on water, including for cooling, reaction media, and solvent extraction. Reliance on water can create a risk for companies, particularly in areas with water scarcity or competing demands.

Key Questions for Investor Engagement

- Has the company conducted an assessment to identify material impacts and dependencies, including from upstream and downstream in the value chain?
- In light of the company's significant reliance on water and the potential for water contamination, has it taken any steps to minimize its water use and improve water treatment practices?
- Has the company taken any steps to manage nature impacts of its products further downstream, including the application of fertilizers or the use of specialty chemicals?
- What steps is the company taking to improve product formulations and design to mitigate negative impacts on nature?
- What steps has the company taken to ensure chemical waste is properly managed? How does the company guarantee that chemical waste does not contribute to air, soil, or water pollution?

For water-related engagement questions, investors can refer to Ceres' Valuing Water Finance Initiative.

Related Resources

- Business for Nature: Chemicals: Sector Actions Towards a Nature-Positive Future
- Ceres: Global Assessment of Private Sector Impacts on Water (Valuing Water Finance Initiative)
- World Business Council for Sustainable Development: SDG Roadmaps: The Chemical Sector and the SDGs
- World Economic Forum: Nature Positive: Role of the Chemical Sector

Consumer Goods Retail Sector

Sector Overview

The consumer goods retail sector encompasses companies that connect producers and manufacturers directly to individual and household consumers to distribute and sell a wide range of durable and non-durable goods—namely, clothing, electronics, household and personal goods, and other packaged goods. Retail companies include traditional brick-and-mortar department and general merchandise stores, specialty retailers of apparel, electronics, home improvement, and other products, and online marketplaces. Across this sector, energy- and water-intensive activities and waste generation cause direct environmental impacts.

The impacts and dependencies described in the sections that follow focus on the direct operations of consumer goods retail companies. However, the bulk of nature impacts and dependencies are upstream with the raw material sourcing, processing, and product manufacturing of consumer goods. Consumer goods retail companies must consider the impacts and dependencies of upstream and downstream (product use and disposal) activities. These are documented in the factsheets for the Biotechnology and Pharmaceuticals, Chemicals, Food, Food and Beverage Retail, Forestry and Packaging, Household and Personal Products, and Metals and Mining sectors.

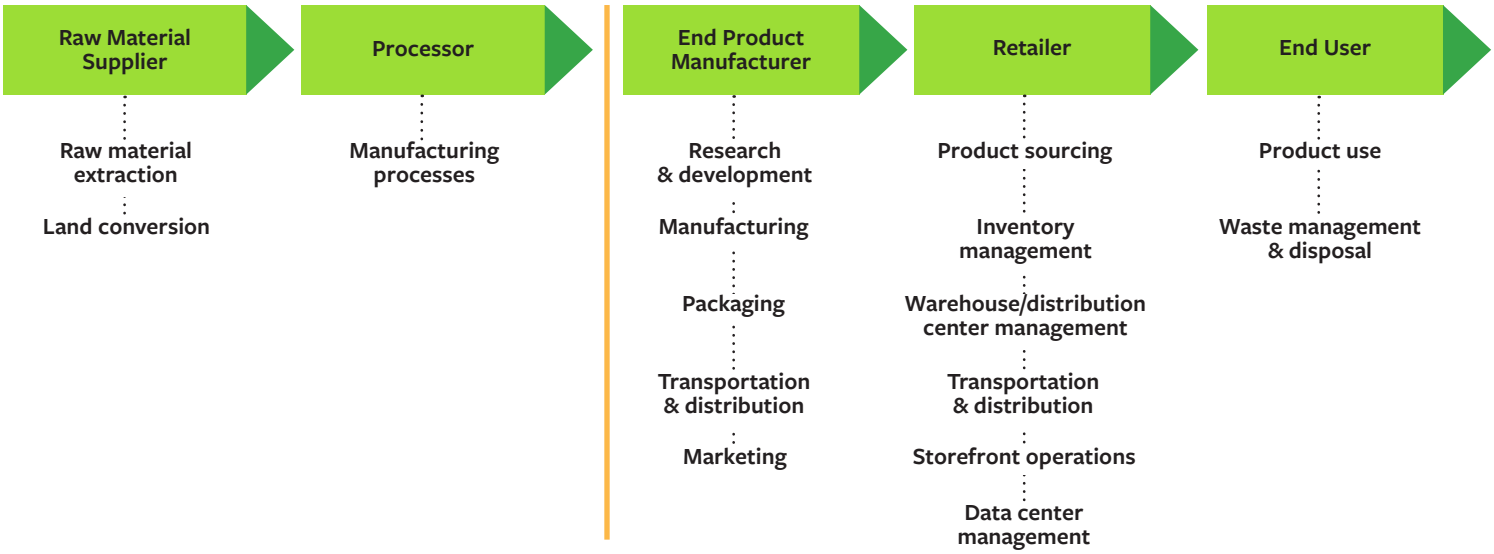

Figure 7. Value chain for the consumer goods retail sector. Consumer goods companies may occupy multiple stages, including end-product manufacturer and retailer. Upstream supply chain stages (yellow line left; raw material supplier and processor) are captured in other factsheets.

Sector Breakdown

Retail

- **Activities:** Key nature-relevant activities for these companies include product sourcing (which may extend to raw material extraction and manufacturing, particularly for owned or private label brands), inventory management, transportation and logistics, warehouse or distribution center operations, and sales and marketing. Many retail companies rely on digital marketplaces in addition to brick-and-mortar storefronts, which also makes data center maintenance and packaging salient.
- **Example companies:** Costco Wholesale Corporation, Target Corporation, The Home Depot, Inc, and Walmart Inc.

E-commerce

- **Activities:** Key nature-relevant activities for e-commerce companies also include product sourcing, inventory management, transportation and logistics (especially shipping), warehouse or distribution center operations, sales and marketing, data center maintenance, and packaging.
- **Example companies:** Amazon.com, Inc., Alibaba Group Holding Limited, eBay Inc, Shopify Inc, and Zalando SE.

Nature-Related Impacts

Impact Category	Retail	E-Commerce
Air Pollution	M	M
GHG Emissions		H
Soil Pollution	H	H
Solid Waste	M	H
Water Pollution	H	H

Figure 8. Material nature-related impacts across the direct operations of the consumer goods retail sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE.

Air, Soil, and Water Pollution

Transportation activities release airborne pollutants such as particulate matter. These emissions can worsen air quality, particularly in urban areas, leading to health and environmental concerns. Electronic waste (e-waste)may cause soil pollution if disposal and recycling are mismanaged and heavy metals or hazardous chemicals leach into the soil. Improper waste disposal may also cause water pollution, with chemicals, heavy metals, microplastics, and other materials leaching into waterbodies and adversely affecting aquatic plants, animals, and ecosystems.

GHG Emissions

Online marketplaces generate significant GHG emissions from the direct energy used to operate data centers, warehouses and distribution centers, and transportation. E-commerce data centers are particularly energy intensive, and the direct-to-customer delivery model emits large quantities of GHG from fossil fuel powered transportation.

Solid Waste

Extensive use of packaging materials, including plastics, cardboard, and Styrofoam, generates a significant waste burden. Many products are packaged using single-use (plastic) materials, which results in post-purchase waste generation. Plastic poses a particular challenge with low global recycling rates (only around 9% is effectively recycled) and millions of tons leaking into terrestrial and aquatic environments where they break down into harmful microplastics. As described above, e-waste is also of significant concern.

Many consumer goods products have a short lifespan by design. For example, rapidly changing trends and technological advancements prompt consumers to dispose of items that are still functional but no longer current. In fast fashion, this business model leads to substantial textile waste, much of which is ultimately landfilled or incinerated. Disposable technology, in the meantime, is creating an e-waste crisis.

Nature-Related Dependencies

Dependency Category	Retail	E-Commerce
Climate Regulation	H	H
Flood and Storm Protection	M	M
Land Stabilization and Erosion Control	M	M

Figure 9. Material nature-related dependencies across the direct operations of the consumer goods retail sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE.

Retail and e-commerce dependencies are specific to their distribution activities. The bulk of material nature-related dependencies for this sector occur in upstream supply chain stages and are summarized in the factsheets for the Biotechnology and Pharmaceuticals, Chemicals, Food, Food and Beverage Retail, Forestry and Packaging, Household and Personal Products, and Metals and Mining sectors.

Climate regulation

Extreme weather impacts the distribution of goods, with record heatwaves, drought, rainfall, snowfall, and flooding disrupting transportation networks and making them less reliable and safe. For example, recent drought conditions have created a chokepoint for global trade at the Panama Canal. Adverse weather events may also make stores inaccessible to consumers, reduce consumer demand, and decrease consumer purchasing power.

Flood and storm protection

Floods and storm surges can submerge roadways and low-lying underpasses, affecting the ability to move goods through transportation networks. In particular, floods can affect shipping channels and the navigability of waterways.

Land stabilization and erosion control

Avalanches and mudslides can damage roads and railroad tracks, disrupting distribution networks for the trade of consumer goods products.

Key Questions for Investor Engagement

- Has the company conducted an assessment to identify material impacts and/or dependencies, including from upstream and downstream in the value chain?
- What steps does the company take to engage upstream suppliers on the embedded nature impacts of goods (e.g., food, household and personal products, metals and mining, timber, pulp, and paper products) sold to consumers? What steps has the company taken to address and mitigate waste generation?
- What steps has the company taken to reduce the impact of its warehousing and distribution activities?
- What steps has the company taken to reduce last-mile emissions and optimize delivery routes?

Related Resources

- McKinsey & Company: How to Prepare for a Sustainable Future along the Value Chain
- Price Waterhouse Coopers: Sustainability in Retail and Consumer Goods: Added cost or source of value?

Food Sector

Sector Overview

The food sector encompasses various stages of agricultural production, ingredient processing, and food manufacturing (additional downstream stages fall under the food and beverage retail sector). Companies can be classified into three primary categories, agriculture, seafood, and processed foods, with some companies spanning multiple categories. Agriculture includes the production of a variety of crops, including food crops, feed crops, and industrial crops (rubber, tobacco)—and livestock such as cattle, chickens, pigs, and sheep. Seafood includes both wild-caught seafood and aquaculture, where seafood (crustaceans, fish, mollusks) is farmed under controlled conditions. Processed food companies manufacture various product types, from baked and canned goods to pet foods to processed and prepared dairy, meat, and seafood products. Companies across the food sector can range from small, local operations to large industrial complexes. Compared to other sectors, the food sector drives some of the largest collective impacts on nature despite significant dependencies on nature.

The impacts and dependencies described in the sections that follow focus on the direct operations of food companies. However, food companies must consider the impacts and dependencies of activities upstream and downstream in their value chain. These activities include those associated with agrochemical use (which are included in the Chemicals Sector factsheet) and food retail (which are included in the Food and Beverage Retail Sector factsheet).

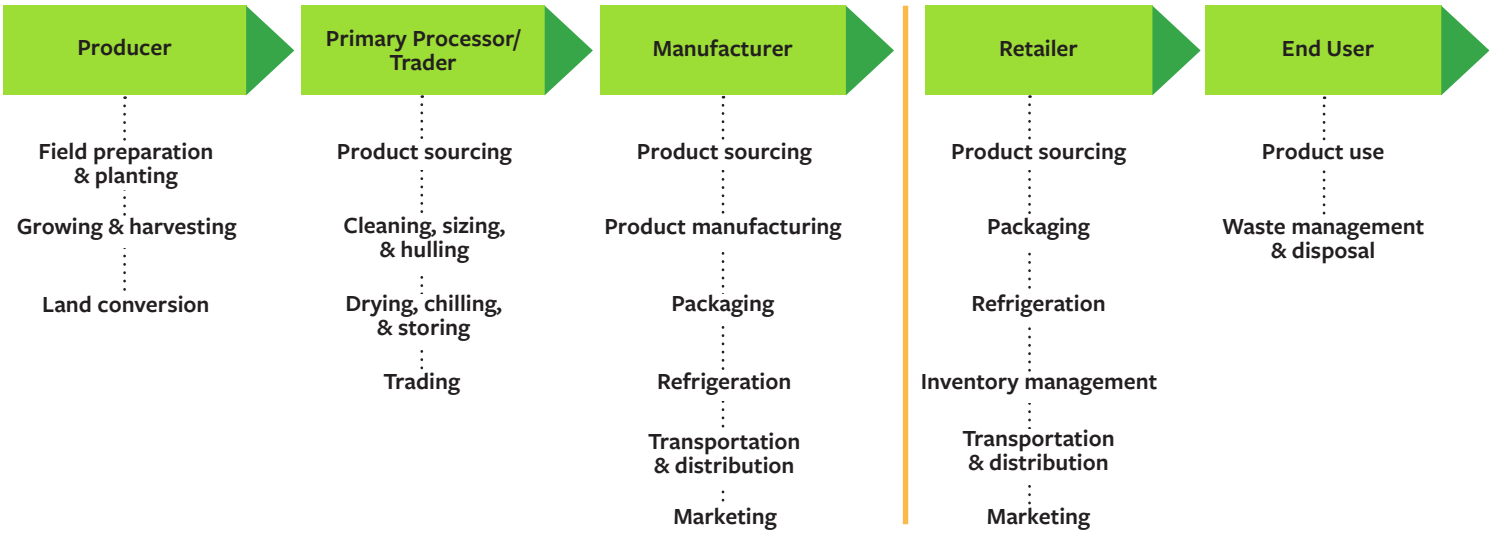

Figure 10. Value chain for the food sector. Food companies may occupy multiple stages, from producer to manufacturer. Downstream supply chain impacts and dependencies (right of the yellow line: retailer and end user) are captured in the Food and Beverage Retail factsheet.

Sector Breakdown

Agriculture

- **Activities:** Key nature-relevant activities for agriculture include expansion, land clearing, and land use change; crop production, inclusive of agrochemical applications; irrigation; harvesting; storing, processing, and transportation; and livestock grazing.
- **Example companies:** Cargill, Dole plc, JBS SA, Sysco Corporation, Syngenta, and Tyson Foods, Inc.

Seafood Production

- **Activities:** Key nature-relevant activities for seafood companies include fishing and pond or reservoir creation for aquacultural operations, as well as processing and transportation.
- **Example companies:** Austevoll Seafood ASA, Cooke Aquaculture Scotland, Dongwon Industries Co, Ltd, High Liner Foods Incorporated, Maruha Nichiro Corp, Nippon Suisan Kaisha Ltd (Nissui Corporation), and Thai Union Group PCL.

Processed Food

- **Activities:** Manufacturing activities, from preparing initial ingredients to packaging final products, have key nature-based impacts and dependencies for processed food companies.
- **Example companies:** Conagra Brands, Inc, General Mills, Inc, Mondelēz International, Inc, Nestlé SA, PepsiCo, Inc, The Kraft Heinz Company, and Tyson Foods, Inc.

Some companies in the food sector are vertically integrated and are involved in agriculture, seafood production, and food processing.

Nature-Related Impacts

Across food sector categories, companies generally share the same nature-related impacts but differ in relative materiality. Importantly, nature-related impacts from feed crop production become embedded in livestock operations. Likewise, the impacts of agriculture and seafood companies are embedded in processed food companies.

Impact Category	Agricultural Commodities		Seafood	Processed Food
	Crops	Livestock		
Air Pollution	H	H		H
Freshwater Ecosystem Use	H		VH	
GHG Emissions		H	H	H
Land Use	VH	VH		
Ocean Use			VH	
Resource Extraction			H	
Soil Pollution	H	M	H	M
Solid Waste				H
Water Pollution	H	H	H	H
Water Use	H	H		H

Figure 11. Material nature-related impacts across the direct operations of the food sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE and Global Assessment for Private Sector Impacts on Water.

Air, Soil, and Water Pollution

- **Agriculture:** Synthetic fertilizers, pesticides, and other agrochemicals can cause air, soil, and water pollution, especially through runoff. When used excessively or without nutrient management techniques, they may wash off fields during rain events. Wastewater generated during agricultural production can release agrochemicals and other contaminants into nearby soils and waterbodies. Agricultural and livestock production can accelerate soil erosion, depositing sediment into nearby waterbodies and degrading aquatic ecosystems and water quality.

- **Seafood:** In aquaculture production systems, especially fish farming, applied nutrients, chemicals, and metals can leach into and pollute oceans. When facilities are located near coastal areas or rivers, nutrient-rich (nitrogen- and phosphorous-containing) wastewater may be released into surrounding waterways and cause aquatic plant growth, including harmful algae blooms.
- **Processed Food:** Processing facilities generate large amounts of wastewater, often containing organic matter, chemicals, and additives. Improper disposal can lead to soil and water contamination. The processed food sector also indirectly contributes to pollution through upstream agricultural operations and the production of packaging materials like aluminum, glass, plastics, and paper/paperboard.

Freshwater Ecosystem Use

- **Agriculture:** Expansion of cropland has led to increased freshwater ecosystem change. Infrastructure projects such as dams, construction of retention ponds, or irrigation canals can interrupt water flow and availability for downstream habitats (for example, drainage of wetlands for irrigation) and cause groundwater depletion.
- **Seafood:** Aquaculture may drive the development of ponds and reservoirs, which can degrade or destroy natural habitats. It may also alter water flow patterns and hinder migration patterns, promote eutrophication, and disrupt riverbed stability. If cultured organisms escape from production sites, they may introduce pathogens. Chemical contaminants, including disinfectants, veterinary medicines, and trace metals, as well as oxygen-consuming substances and nutrients, such as excrement and uneaten fish food, may have toxic effects when they enter freshwater ecosystems.

GHG Emissions

- **Agriculture:** Food sector emissions account for approximately one-third of global anthropogenic GHG emissions, with the majority stemming from growing crops, raising livestock, and land use and land use change, including deforestation. Livestock, particularly cattle, emit large quantities of potent methane and nitrous oxide gases.
- **Seafood:** Aquaculture and fisheries account for another 10% of total agricultural emissions. On average, ocean trawling is responsible for one gigaton of carbon emissions per year.
- **Processed Food:** Food processing companies emit 0.6 billion tons of carbon dioxide equivalent per year from combustion and energy use.

Across all sectors, transportation and refrigeration also generate significant GHG emissions.

Land Use

- **Agriculture:** Agriculture occupies over half of the world's habitable land, and continued expansion drives the conversion of forests and other natural ecosystems to additional pasture and cropland. Nearly 90% of global deforestation is attributable to agricultural expansion. These practices destroy natural habitats, disrupt ecosystem function, and reduce biodiversity, which results in land degradation, species loss, and soil erosion. Overuse and monocropping also contribute to biodiversity loss, soil degradation, and soil depletion.
- **Processed Food:** Most of the impacts that processed food companies have on land use arise from upstream activities such as agricultural production. For example, palm oil, a crop associated with extensive tropical deforestation—especially in Southeast Asia—is a ubiquitous ingredient in processed foods. However, long and opaque supply chains can make it challenging for companies to identify their linkages to these and other upstream impacts. Companies also drive land use impacts through the timber, pulp, and paper supply chains behind their packaging materials.

Ocean Use

- **Seafood:** Certain fishing methods, such as trawling and dredging, can severely degrade ocean habitats. Aquaculture is also a source of ocean degradation—the impacts on ocean ecosystems mirror those of freshwater ecosystems. Aquaculture expansion has led to the conversion of nearly 19,000 square kilometers of mangroves since 1980.

Resource Extraction

- **Seafood:** The FAO reports that over a third of global fishery stocks are overexploited, threatening biodiversity and disrupting the balance of marine ecosystems. In severe cases, it can collapse fish populations and degrade entire ecosystems.

Solid Waste

- **Processed Food:** Plastic packaging, food waste, and processing byproducts can increase environmental pollution. Food and food packaging materials make up almost half of all municipal solid waste. Food waste occurs across various stages of production, distribution, and consumption, contributing to substantial greenhouse gas emissions and driving further resource use. Most packaging is designed for one use and is typically thrown away rather than reused or recycled.

Water Use

- **Agriculture:** Crop and livestock production requires significant water consumption, which can degrade freshwater ecosystems, cause or compound local water stress, and increase the risk of drought. Livestock production has a particularly large water footprint, primarily from the water demands of raising the crops used to feed animals. For example, on average, 1,847 gallons of water are needed to produce one pound of beef compared to 39 gallons of water for one pound of vegetables.
- **Processed Food:** Processed foods require far more water than their unprocessed or minimally processed counterparts, with many processing activities demanding large quantities of water. The extent of water use depends on the scale of production and the efficiency of water management within processing facilities.

Nature-Related Dependencies

Dependency Category	Agricultural Commodities		Seafood	Processed Food
	Crops	Livestock		
Enabling Services	● VH	● VH	● VH	● M
Mitigating Services	● M	● M	● M	
Protecting Services	● VH	● VH	● VH	● M
Provisioning Services	● VH	● VH	● VH	● VH

Figure 12. Material nature-related dependencies across the direct operations of the food sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE.

Across food sector categories, companies generally share the same nature-related dependencies but differ in relative materiality. Importantly, nature-related dependencies for crops are embedded in livestock production, and dependencies for agriculture and seafood are embedded in processed foods. The food sector's dependencies are considerable. For the purposes of this factsheet, the dependencies are condensed into broader groupings of ecosystem services.

Enabling Services

Enabling ecosystem services, including pollination, nursery habitat maintenance, soil quality, water quality, and water flow maintenance, underpin food production processes by supporting overall ecosystem health and resilience.

- **Agriculture:** Agricultural production relies on ecosystem services, including the provision of nurseries (habitats that support reproduction and provide a safe environment for young organisms to grow), pollination, soil quality, ventilation, water flow maintenance, and water quality. For example, 35% of global food crops depend on pollination, and healthy soils are imperative for providing nutrients, anchoring plants, and retaining moisture. Water flow maintenance—which naturally occurs through the Earth's water cycle—is imperative to ensure consistent and controlled water availability for production. In the context of livestock, soil quality is an important precursor to nutritious forage on pasture and grazing lands and feed production. Clean water access directly impacts livestock health.
- **Seafood:** Soil and water quality are critical to the health and productivity of seafood operations. For example, many bottom-dwelling species, such as clams and mussels, require well-oxygenated sediments. Proper water quality and flow in rivers, estuaries, coastal areas, and other waterbodies is essential for sustaining the health of natural habitats, including spawning grounds, and optimal environmental conditions in some types of aquaculture facilities. Many seafood species also depend on nursery habitats, including mangroves, seagrass beds, and estuaries, for early and reproductive life stages.
- **Processed Food:** As water is a necessary input for cleaning raw materials and ingredients, water quality is essential for ensuring that food safety, quality, and hygiene standards are met. Proper water flow maintenance is crucial for ensuring the availability of freshwater in ground and surface water reservoirs serving the municipalities where manufacturing takes place.

Mitigation Services

Mitigation ecosystem services include bioremediation (degradation and detoxification of contaminants by microorganisms, waste dilution, and the filtration of pollutants.

- **Agriculture:** Bioremediation in agriculture is important for reducing pesticide contamination in soils and revitalizing soils in an efficient, cost-effective, and ecofriendly way. Biological filtration and dilution processes remove and control the concentration of pollutants from crop and livestock agriculture to support healthy air, water, and soils.
- **Seafood:** Natural bioremediation and waste dilution processes help to maintain water quality and support the overall well-being of seafood species. When overloaded, aquatic ecosystems may increase the uptake, retention, and bioaccumulation of contaminants in fish.

Protecting Services

Ecosystem services in this category—including climate regulation, disease control, flood and storm protection, land stabilization and erosion control, pest control, and the transport and storage of sediment—protect food production processes from disruption.

- **Agriculture:** Stable climate conditions are essential for growing crops, raising livestock, and providing suitable working conditions for agricultural field workers. Farms also rely on mangroves and wetland ecosystems to buffer farms and livestock against extreme weather events, such as hurricanes, storm surges, and flooding. Other ecosystems, particularly forests, grasslands, and riparian vegetation, help stabilize soils and prevent their erosion, which is vital for maintaining soil fertility, avoiding sedimentation, and protecting crop yields. Healthy ecosystems also support natural predators and competitors of crop pests and disease vectors, such as birds and helpful insects, which reduce the need for chemical pesticides.

- **Seafood:** Wetlands, mangroves, and coastal marshes buffer the movement of sediment, which reduces the impact of heavy rainfall, runoff from inland areas, and storm surges, ensuring the integrity of seafood habitats and minimizing disruption to breeding and feeding grounds. These ecosystems also regulate temperatures, decompose waste, and eliminate harmful pathogens to maintain water quality.
- **Processed Food:** Processing facilities, including buildings, equipment, and storage facilities, could be vulnerable to flooding and storms, particularly if located in floodplains. Flooding or storm damage could disrupt these operations, causing supply chain delays or lost products.

Provisioning Services

Provisioning services are a broad category of ecosystem services that provide direct physical inputs, such as fibers and fodder, genetic matter, which includes all plants, animals, and algae, and water resources for food production.

- **Agriculture:** Rainfed and irrigated crops depend on access to ground and surface water sources, with groundwater particularly crucial for irrigation. Ground and surface water availability is also critically important for raising livestock, not only for direct consumption but also to produce feed and fiber (such as straw for bedding). At the same time, crop production depends on a diverse array of genetic materials to develop and maintain varieties that are well-suited to specific environments and exhibit other commercially desired traits.
- **Seafood:** In wild-caught fish, genetic diversity helps maintain healthy and resilient populations. Surface water, including oceans, seas, rivers, and lakes, provides critical habitat for wild-caught and farmed seafood.
- **Processed Food:** Water is used throughout manufacturing for cleaning equipment and processing (for conveying, heating, cooling, rinsing, dissolving, dispersing, diluting, separating, etc.). It is also a common ingredient.

Key Questions for Investor Engagement

- Has the company conducted an assessment to identify material impacts and dependencies, including from upstream and downstream in the value chain?
- Does the company have a no-deforestation and no-conversion policy? Ceres' Deforestation Ask Strategy provides a comprehensive list of engagement questions for investors.
- How is the company supporting biodiversity and ecosystem conservation efforts, particularly for high conservation value locations?
- What agricultural practices does the company use or encourage suppliers to use to enhance soil health, reduce the need for chemical inputs, and increase agricultural biodiversity?
- How does the company avoid nature-related impacts such as habitat degradation, water flow alteration, and mangrove/wetland conversion in its aquaculture activities?
- What specific steps and initiatives has the company taken to ensure the sustainability of its freshwater and/or marine fishing activities? How is the company protecting stocks from overfishing, minimizing environmental impacts, and practicing effective fisheries management?

For water-related engagement questions, investors can refer to Ceres' Valuing Water Finance Initiative.

Related Resources

- Business for Nature: Agri-Food Sector Actions Towards a Nature-Positive Future
- Ceres: Evaluating Corporate Actions to Eliminate Deforestation
- Ceres: Global Assessment of Private Sector Impacts on Water (Valuing Water Finance Initiative)
- Ceres: Investor Guide to Deforestation and Climate Change
- FishChoice: Sustainable Seafood 101
- Taskforce on Nature-related Financial Disclosures (TNFD): Draft Sector Guidance: Food and Agriculture
- World Business Council on Sustainable Development: Food and Agriculture Roadmap

Food and Beverage Retail Sector

Sector Overview

The food and beverage retail sector includes companies that distribute and sell packaged, fresh, and prepared foods, as well as alcoholic and nonalcoholic beverages. Retailers include supermarkets, grocery stores, convenience stores, and specialty stores. They play a critical role in maintaining product quality and safety while creating a pleasant shopping environment for consumers. Distributors specialize in supplying and transporting food and beverage products to retail outlets.

The impacts and dependencies described in the sections that follow focus on the direct operations of food and beverage retail companies. However, the food and beverage retail and food sectors are closely linked due to overlapping sourcing, transportation, and manufacturing responsibilities. As a result, companies in both sectors have a joint responsibility to address the environmental impacts of their activities, such as air, water, and soil pollution, greenhouse gas emissions, habitat disruption, resource consumption, and waste generation. Upstream impacts and dependencies are documented in the Food Sector factsheet.

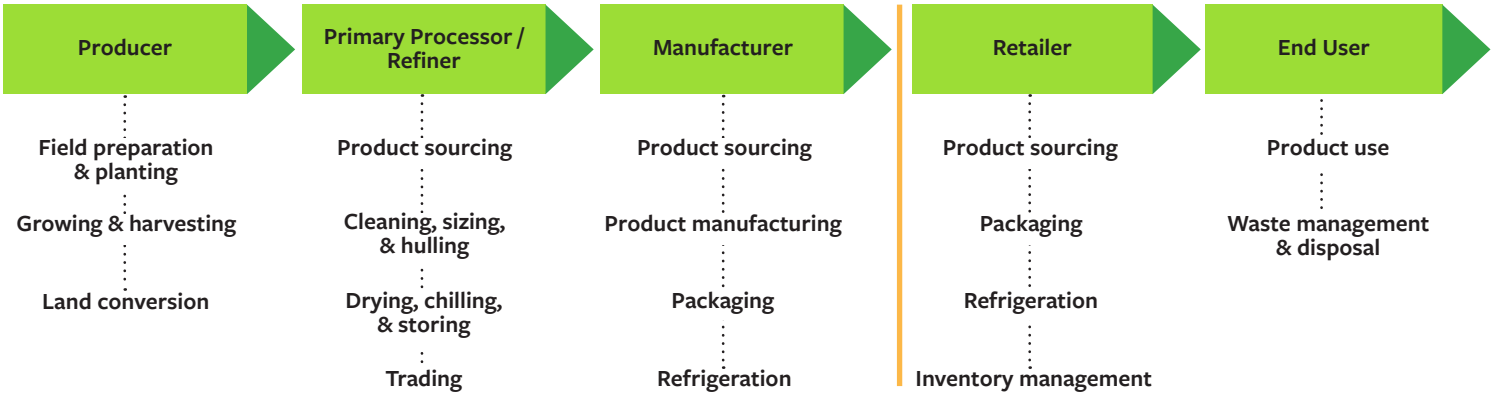

Figure 13. Value chain for the food and beverage retail sector. Upstream supply chain stages (left of the yellow line: producer, trader, and processor) are captured in the Food Sector factsheet.

Sector Breakdown

Distribution

- **Activities:** Key nature-relevant activities for food and beverage distribution companies include packaging, warehousing, and transportation.
- **Example companies:** KeHE Distributors, Sysco Corporation, and United Natural Foods, Inc.

Retail

- **Activities:** Key nature-relevant activities for food and beverage retail companies include operating retail and warehouse stores, managing inventory, and marketing (influencing consumer habits).
- **Example companies:** Carrefour SA, Koninklijke Ahold Delhaize NV, The Kroger Co, Walmart Inc, and Whole Foods Market.

Nature-Related Impacts

Impact Category	Distribution	Retail
Air Pollution	H	M
Disturbances	H	
GHG Emissions	H	
Marine Ecosystem Use	M	
Soil Pollution		H
Solid Waste		M
Water Pollution		H
Water Use		H

Figure 14. Material nature-related impacts across the direct operations of the food and beverage retail sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE.

Many of the material nature-related impacts for the food and beverage retail sector occur in upstream supply chain stages and are summarized in the Food Sector factsheet.

Air, Soil, and Water Pollution

As companies distribute products from production facilities to retail locations, vehicle emissions pollute the air. Retail outlets rely on large refrigeration systems that can release ozone-depleting refrigerants if they are not properly maintained. Upstream, waste and discharges from manufacturing facilities can contaminate soils and waterbodies through runoff. These manufacturing facilities generate large amounts of wastewater, often containing organic matter, chemicals, and additives. The food and beverage retail sector may also indirectly contribute to soil and water pollution associated with agricultural activities and the production of packaging materials, including plastics and aluminum.

GHG Emissions

The transportation, storage, and distribution of food items are associated with significant GHG emissions. Food can be transported by ship, air, rail, and trucks. Refrigeration is another source of GHG emissions—refrigerants such as chlorofluorocarbons and hydrochlorofluorocarbons can be emitted through leaks and accidental releases. The refrigeration needed to keep food cold as it moves through the supply chain (cold chain technologies) is particularly carbon intensive. Food waste, resulting from poor storage and handling, spoilage in transport and processing, and disposal by retailers and consumers, also has a significant impact on the sector's carbon footprint.

Solid Waste

Food waste contributes to billions of tons of solid waste each year in the U.S. alone. The sector relies on significant amounts of packaging to facilitate distribution, transportation, and retail, which drives heavy single-use plastic consumption (and waste generation) in particular. More environmentally sustainable packaging solutions have been slow to develop, and companies often overemphasize recycling practices rather than exploring innovative packaging alternatives.

Nature-Related Dependencies

Dependency Category	Distribution	Retail
Climate Regulation	H	
Flood and Storm Protection	M	
Land Stabilization and Erosion Control	M	

Figure 15. Material nature-related dependencies across the direct operations of the food and beverage sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE.

Many of the material nature-related dependencies for the food and beverage retail sector occur in upstream supply chain stages and are summarized in the Food Sector factsheet.

Climate regulation

Adverse weather and climate events impact the distribution of food. The impacts can be particularly risky because food requires proper storage and refrigeration to avoid spoilage. Extreme temperatures and precipitation can disrupt transportation networks as transportation infrastructure becomes less reliable and unsafe. Adverse weather events may also make stores inaccessible to consumers, reduce consumer demand, and decrease consumer purchasing power.

Flood and storm protection

Floods and storm surges can submerge roadways, affecting the ability to move food across transportation networks. In particular, floods can affect shipping channels and the navigability of waterways.

Land stabilization and erosion control

Avalanches and mudslides can damage roads and railroad tracks, disrupting distribution networks for the trade of food products.

Key Questions for Investor Engagement

- Has the company conducted an assessment to identify material impacts and/or dependencies, including from upstream and downstream in the value chain?
- Does the company engage suppliers on the nature impacts of producing food and beverage products, including addressing air, soil, and water pollution, water use, habitat degradation, and loss of pollinators?
- Does the company engage with suppliers to eliminate deforestation and conversion from its supply chain?
- Has the company taken steps to transition to low-impact refrigerants and to prevent and address leaks and accidental releases of refrigerants?
- What steps has the company taken to reduce last-mile emissions and optimize delivery routes?
- What steps has the company taken to reduce the impact of its warehousing and distribution centers?
- How does the company address and mitigate the generation of waste in its operations, especially single-use plastics, and what initiatives are in place for waste reduction and responsible disposal?

Related Resources

- Capitals Coalition: Food and Beverage Sector Guide
- Ceres and PRI: Global Sector Strategies: Recommended Investor Expectations for Food and Beverage Sector
- Client Earth: Material Issues: Big Food and the Rise of Plastic-Related Waste
- Ellen MacArthur Foundation: Big Food Redesign
- Taskforce for Nature-related Financial Disclosures: Draft Sector Guidance - Food and Agriculture

Forestry and Packaging Sector

Sector Overview

This forestry and packaging sector covers both forest management and pulp and paper products. Forest management includes the establishment and management of all types of forests, as well as the harvest and production of timber products such as sawlogs, plywood, pulpwood, fuelwood, used for furniture, building materials, and bioenergy. Pulp and paper production includes the processing and manufacture of newsprint, office paper, paper packaging, tissue, and related products. Pulp and paper production accounts for 13-15% of global wood consumption and 33–40% of industrial wood trade. The U.S. is the world's largest pulp producer and U.S. paper and paperboard production and consumption rates are second only to China. Given their reliance on timber and other wood products, pulp and paper companies are intrinsically linked to forest management companies—and the nature-related impacts and dependencies of the forestry industry extend to pulp and paper production.

The impacts and dependencies described in the sections that follow focus on the direct operations of companies in the forestry and packaging sector. However, companies must consider the impacts and dependencies of upstream and downstream activities, such as those associated with agrochemical use (which are included in the Chemicals Sector factsheet), as well as those associated with end markets and end users (such as packaging use in Consumer Goods Retail).

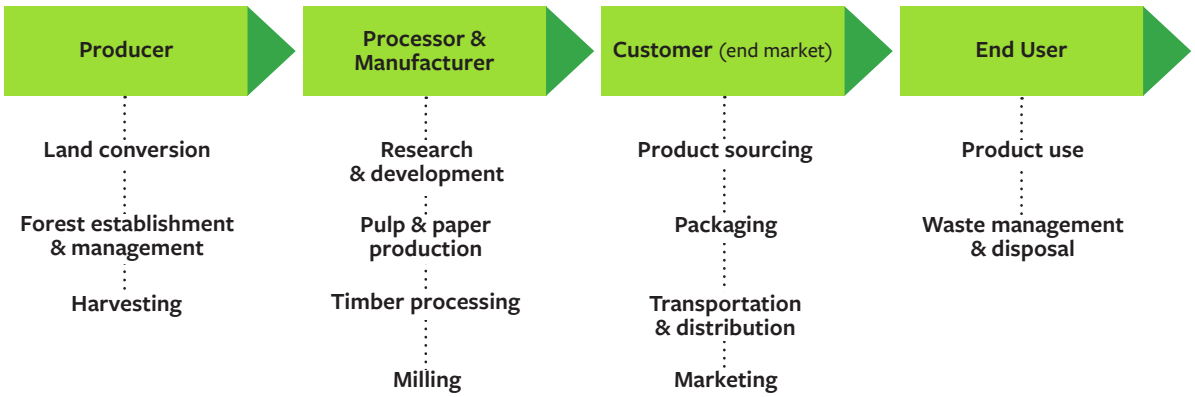

Figure 16. Value chain for the forestry and packaging sector.

Sector Breakdown

Forest Management

- **Activities:** Key nature-relevant activities include establishing, managing, and harvesting timber and producing wood-based products.
- **Example companies:** Domtar, Metsä Board Oyj, Mohawk Industries, Inc, Rayonier Inc, Stora Enso Oyj, Suzano SA, West Fraser Timber Co Ltd, and Weyerhaeuser Company.

Pulp and Paper Products

- **Activities:** Key nature-relevant activities include log processing, pulp production, and paper/packaging manufacturing.
- **Example companies:** IInternational Paper Company, Georgia-Pacific, Kimberly-Clark Corporation, and Mondi plc.

Some companies in this sector are vertically operated and have both forest management and pulp and paper production activities.

Nature-Related Impacts

Impact Category	Forest Management	Pulp and Paper Products
Air Pollution		M
GHG Emissions	H	
Soil Pollution	H	H
Land Use	VH	
Water Pollution	VH	VH
Water Use		H

Figure 17. Material nature-related impacts across the direct operations of the forestry and packaging sectors. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE and Global Assessment for Private Sector Impacts on Water.

Air, Soil, and Water Pollution

- **Forest Management:** Heavy machinery and leachate from wood waste piles cause soil pollution. Forest management activities, from site preparation and fertilizer use to timber harvesting, may contaminate water sources and aquatic habitats with metals, nutrients, organic matter, and sediments. Degraded soils may be unable to support continued forest growth—resulting in stunted trees or plantation failures.
- **Pulp and Paper Products:** Wood pulping and pulp bleaching processes pollute the air with sulfur compounds and nitrogen oxides. Waste disposal practices can pollute soils and hinder their capacity to provide and regulate important ecosystem processes such as nutrient uptake, decomposition, and water availability. The pulp and paper industry releases hundreds of thousands of tons of toxic pollution each year. Pulp and paper manufacturing activities can also discharge large quantities of wastewater containing sediments, effluent solids, nutrients, toxic chemicals (chlorine, iodine, sulfur dioxide), and organic compounds into waterbodies. These pollutants damage aquatic ecosystems as they acidify water and create oxygen, nitrogen, and carbon cycle imbalances.

GHG Emissions

- **Forest Management:** Deforestation is a major contributor to climate change, and forest degradation may generate even more carbon emissions than deforestation. Industrial logging practices, such as clearcutting, release carbon from soils and the biomass that is left behind. While forests can regrow, it can take centuries to compensate for the resulting impact on the climate. Heavy machinery emits additional greenhouse gases.

Land Use

- **Forest Management:** Nearly a third of global forests (1.15 billion hectares) are used primarily for production. Practices such as clearcutting, selective harvesting, monoculture planting, and non-native species cultivation degrade forest ecosystems by reducing biodiversity, damaging and eroding soils, increasing pest and disease prevalence, and heightening fire risks.

Water Use

- **Pulp and Paper Products:** This industry consumes large volumes of water to produce paper products, with 85% of water used in the industry related to the production process. The growing demand for paper products will intensify the pressures on freshwater globally.

Nature-Related Dependencies

Dependency Category	Forest Management	Pulp and Paper Products
Bioremediation	M	
Enabling Services	VH	M
Protecting Services	VH	
Provisioning Services	VH	VH

Figure 18. Material nature-related dependencies across the direct operations of the forestry and packaging sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE.

Bioremediation

- **Forest Management:** Healthy forest ecosystems provide bioremediation services that mitigate the accumulation of pesticides, herbicides, heavy metals, and other pollutants from machinery. Microorganisms, trees, and other forest plants in healthy ecosystems absorb and degrade contaminants to detoxify soils so that forests can thrive. However, degraded ecosystems will be less effective at bioremediation, jeopardizing forest production.

Enabling Services

These ecosystem services, including pollination, soil quality, and water flow maintenance, enable forest production processes by supporting overall ecosystem health and resilience.

- **Forest Management:** A number of tree species rely on the pollinating services of insects, birds, and bats. These pollination services contribute to overall forest health by facilitating biological reproduction, preventing inbreeding, and maintaining biodiversity. Forests also need fertile soils to grow and to store and deliver water resources. Industrial logging practices degrade and erode soil, which can reduce forest productivity and increase operating costs.

Protecting Services

These ecosystem services, including climate regulation, natural disease and pest control, flood and storm protection, land stabilization, and erosion control, protect forest production processes from disruption.

- **Forest Management:** Warmer temperatures, changes to precipitation, extreme weather events, and shifting pest patternsnegatively impact forest production. Protecting services are critical for healthy forests as climate change increases forest susceptibility to disturbances, such as fires, droughts, invasive species, pests, and diseases. For example, climate change is creating longer fire seasons and more extreme fire conditions, causing substantial and increasing global losses of timber. By increasing the diversity of tree species, forest managers can rely on natural disease and pest control to mitigate monoculture forests' vulnerability to disease and pests. Artificial controls (pesticides, insecticides) may be used, but they have the potential to reduce forest integrity by suppressing natural systems of control, harming local biodiversity, and increasing the likelihood of future pest outbreaks.

Provisioning Services

Provisioning services are a broad category of ecosystem services that provide direct physical inputs to forest management and pulp and paper production.

- **Forest Management:** The forest management and timber industry is predicated on wood production which, in turn, relies on water resource availability.
- **Pulp and Paper Products:** The paper industry is highly dependent on wood fiber from the forest management industry. Water resources are also indispensable to pulp and paper manufacturing processes. It is used for activities such as cooking wood chips to make pulp, transporting paper constituents through paper machines, and cleaning machinery.

Key Questions for Investor Engagement

- Has the company conducted an assessment to identify material impacts and dependencies, including from upstream and downstream in the value chain?
- Does the company adhere to a recognized standard for sustainable forest management (e.g., Forest Stewardship Council)? If so, what proportion of its operations are certified?
- Does the company use fertilizers, pesticides, or other agrochemicals? How does it ensure these compounds do not pollute nearby waterbodies or accumulate in and degrade soils?
- Are the forests under the company's management monoculture plantations?
- Has the company taken action to restore areas of significant biodiversity and carbon value, habitat connectivity, or native or endangered tree species?
- Does the company know where it is sourcing material from for its pulp and paper facilities? What action has the company taken to reduce its reliance on virgin materials?
- Has the company taken any steps, such as using recycled, recirculated, or treated water, to reduce its freshwater consumption?
- What practices does the company implement to minimize its release of air pollutants, including nitrous oxides and sulfur dioxide?

For water-related engagement questions, investors can refer to Ceres' Valuing Water Finance Initiative.

Related Resources

- Business for Nature: Forest Products: Sector Actions Towards a Nature-Positive Future
- Ceres: Global Assessment of Private Sector Impacts on Water (Valuing Water Finance Initiative)
- Food and Agriculture Organization: Sustainable Forest Management Toolbox & Learning Modules
- Rainforest Alliance: What is Sustainable Forestry?
- Sustainable Packaging Coalition: Guide to Verifying Sourcing of Fiber

Household and Personal Products Industry

Sector Overview

Household and personal products, a sub-industry of the consumer goods sector, is made up of companies that manufacture goods for personal and commercial consumption, ranging from cosmetics to soaps and detergents. Many of the inputs used for manufacturing personal goods products come from the biotechnology and pharmaceuticals and chemicals sectors. The sector heavily relies on natural resources for raw materials—palm oil is a key ingredient for the products in this industry. Household and personal product companies typically sell their products through consumer goods retail companies.

While the impacts and dependencies described in the sections that follow focus on the direct operations of companies in the household and personal products sector, companies must consider the impacts and dependencies of upstream and downstream activities. These are documented in other factsheets, such as those on the Biotechnology and Pharmaceuticals, Chemicals, Food, Consumer Goods Retail, Forestry and Packaging, and Metals and Mining sectors.

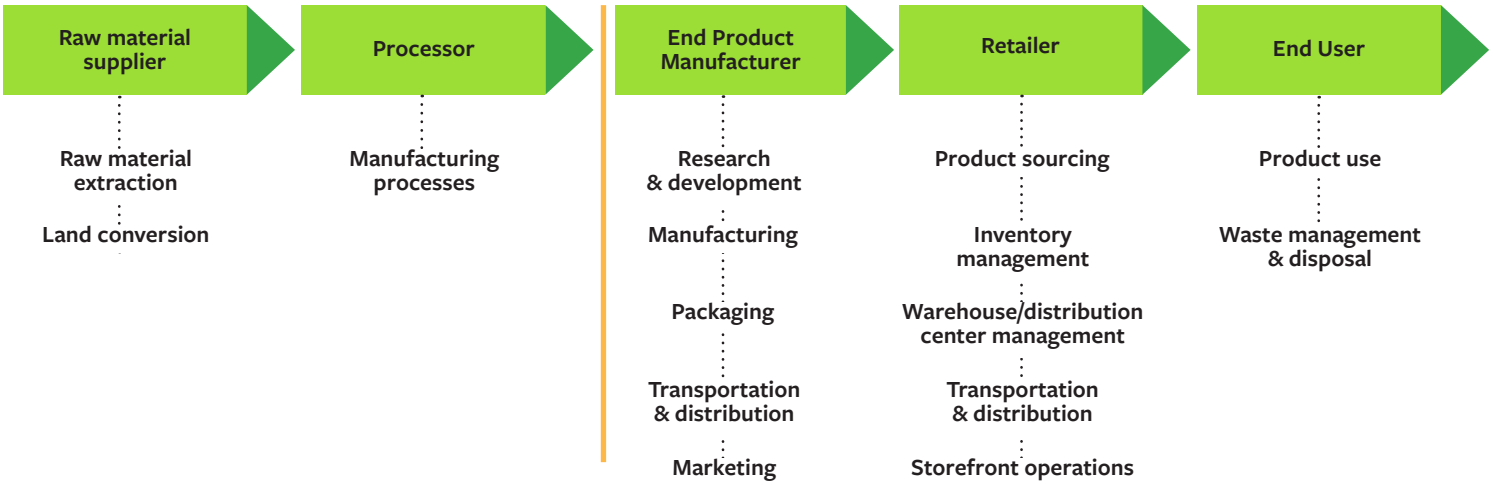

Figure 19. Value chain for the household and personal products sector. Upstream supply chain impacts (left of yellow line: raw material supplier and processor) are captured in other factsheets.

Sector Breakdown

- **Activities:** Key nature-relevant activities for the household and personal products sector include the sourcing of raw materials, research and development, manufacturing, packaging, and distribution and sales.
- **Example companies:** Colgate-Palmolive Company, The Esteé Lauder Companies Inc, Essity AB, L'Oreal SA, Natura Cosmeticos, The Procter & Gamble Company, and Unilever plc.

Nature-Related Impacts

Impact Category	Household and Personal Products
Air Pollution	M
GHG Emissions	H
Soil Pollution	M
Solid Waste	H
Water Pollution	M

Figure 20. Material nature-related impacts across the direct operations of the household and personal products sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE and Global Assessment for Private Sector Impacts on Water.

Air, Soil, and Water Pollution

Compounds used to produce assorted household and personal products, such as volatile organic compounds, heavy metals, and solvents, may be released during production through wastewater discharge and can accumulate in soils and waterbodies and persist for extended periods. When used, certain cleaning supplies and other household and personal products emit volatile organic compounds and other substances that can contribute to air quality issues and human health concerns. Soil and water pollution can also occur when products, such as batteries, chemical cleaners, and detergents, are not properly disposed of. When phosphates from laundry and dishwasher detergents run off into waterbodies, they cause eutrophication, slowly killing freshwater aquatic ecosystems due to oxygen depletion.

GHG emissions

Production processes, such as manufacturing, transportation, and packaging, generate GHG emissions. However, the majority of the sector's emissions are generated upstream and downstream by suppliers and customers. Upstream emissions occur when companies extract raw materials, such as petroleum to create plastics and palm oil for cosmetics. Downstream emissions occur in the product use phase. For example, when customers take hot showers or wash their clothes.

Solid Waste

Plastic, microplastic, and solid waste (wipes, face masks, diapers) are a large source of pollution for the household and personal goods sector when they aren't properly disposed of. In addition, the plastics used for packaging, such as toothpaste tubes, lotion bottles, or cosmetics containers, are difficult to recycle, with 22% of this waste ending up in land and marine ecosystems.

Nature-Related Dependencies

Dependency Category	Household and Personal Products
Fibers and Other Materials	M
Water Quantity	H

Figure 21. Material nature-related dependencies across the direct operations of the household and personal products sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE.

Fibers and Other Materials

Household and personal products—and their packaging—rely on a variety of raw materials, from botanical extracts to metals and minerals. For example, companies may rely on plant-based oils for skincare products or minerals for cosmetic pigments and then use pulp and paper to package these products.

Water Resources

Water is irreplaceable for many production processes. For example, it is often used for rinsing and purifying products during various stages of manufacturing and for cleaning packaging materials such as bottles and containers. Water is also a key ingredient in many household and personal goods. In many products, it acts as a solvent for dissolving and mixing various ingredients, and it is instrumental in creating the desired consistency, effectiveness, and texture in products like creams, soaps, and lotions.

Key Questions for Investor Engagement

- Has the company conducted an assessment to identify material impacts and dependencies, including from upstream and downstream in the value chain?
- What steps has the company taken to replace and remove hazardous and toxic ingredients, including volatile organic compounds (VOCs), from its products?
- What strategies does the company have in place to minimize soil pollution risks associated with its manufacturing or waste disposal practices?
- What steps has the company taken to source responsibly and replace feedstocks with sustainable, bio-based, or other renewable materials?
- What steps has the company taken to change consumer behavior on product use (for example, reducing water usage) and disposal (for example, encouraging recycling)?
- To what extent is the company expanding the circularity of its operations, products, and packaging?

For water-related engagement questions, investors can refer to Ceres' Valuing Water Finance Initiative.

Related Resources

- Business for Nature: Household & Personal Care Products: Sector Actions Towards a Nature-Positive Future
- World Economic Forum: Nature Positive: Role of the Household and Personal Products Sector

Metals and Mining Sector

Sector Overview

Key activities in this sector include extracting metals and minerals, producing ores, smelting and manufacturing metals, and refining metals. Metal extraction includes the extraction of primarily gold, silver, iron, copper, lead, and zinc used to produce goods like jewelry, electronics, and steel. Mineral mining involves the extraction of materials like coal, graphite, lithium, and cobalt used to produce energy, paints, and batteries, among other goods. The demand for minerals is expected to surge, especially with the need for clean energy technologies. By 2050, mineral production is projected to increase by nearly 500% to support growing wind, solar, and geothermal power production, storage, and transmission infrastructure. The booming appetite for minerals and metals has pushed mining operations into new areas—including growing interest in deep-sea mining—often impacting biodiversity-rich natural biomes and local communities. As demand for metals and minerals continues to rise, the sector's expansion can lead to increased habitat destruction, water pollution, and disruption of ecosystems.

The impacts and dependencies described in the sections that follow focus on the direct operations of metals and mining companies. However, companies must consider the impacts and dependencies of downstream (product manufacturing, transportation, distribution, use, and disposal) activities.

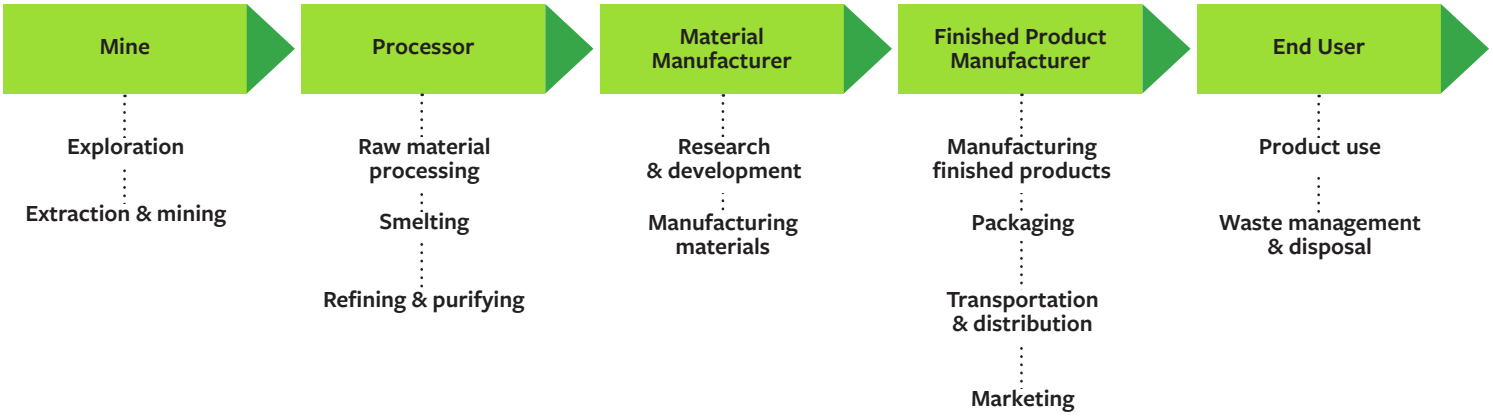

Figure 22. Value chain for the metals and mining sector. Metals and mining companies may occupy multiple stages, typically mine, processor, and material manufacturer.

Sector Breakdown

Activities

- **Extraction and mining:** The most common types of mining are open-pit and underground mining. Placer mining, a technique to extract raw materials from sand or gravel (such as in riverbeds), and in-situ mining, leaving ore in the ground and recovering the minerals from it by dissolving them and pumping them to the surface, are other approaches to extraction.
- **Processing:** After mining, the material is processed to separate the mineral or metal from the ore. Processing methods can include any combination of crushing, grinding, washing, and chemical treatment, depending on the type of metal or mineral being produced.

- **Refining:** The metal or mineral product may undergo further refining to achieve the desired solid, liquid, or dissolved state and purity.

Example companies: BHP Group Limited, Glencore plc, Mitsubishi Corporation, Norsk Hydro ASA, Newmont Corporation, Rio Tinto Group, and Vale SA.

Nature-Related Impacts

Impact Category	Mining	Processing	Refining
Air Pollution	H	M	
Disturbances	H		
Freshwater Ecosystem Use	H		
GHG Emissions	H	H	H
Land Use	VH		
Soil Pollution	H	M	H
Solid Waste	H	H	H
Water Pollution	VH	VH	VH
Water Use	H	H	H

Figure 23. Material nature-related impacts across the direct operations of the metals and mining sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE and Global Assessment for Private Sector Impacts on Water.

Air, Soil, and Water Pollution

Mines can leach wastewater that is acidified or contains high concentrations of heavy metals (such as mercury, arsenic, and lead) and other toxic chemicals (including sulfuric acid and cyanide). These pollutants have devastating consequences on ecosystems, contributing to biodiversity loss of vegetation and aquatic life.

All stages of the mining process create air pollution. Excavation, blasting, and transportation of materials create dust. Processing ore into metal requires high temperatures to release the metal from other materials in the ore. The process releases lead, nitrogen, sulfur, mercury, sulfur dioxide, zinc, cadmium, and uranium.

Dust clouds and mineral deposition from mines can alter soil characteristics, making it unsuitable for supporting native vegetation. Additionally, trace elements near opencast mining sites may include heavy metals and toxic substances, which can leach into the surrounding soil, causing long-term impacts on soil quality.

A critical water quality challenge with mining, especially in open-pit mines, is acid rock drainage, which occurs when sulfide minerals oxidize and create in acidic waters. Acid rock drainage is one of the industry's most serious environmental challenges and its largest environmental liability. The resulting acidic fluids are highly toxic and, when mixed with groundwater, surface water, and soil, can harm humans, animals, and plants. In addition, tailings from mines, which consist of pulverized rock, water, and residual extraction chemicals, are stored in dams. Dam failures can release pollutants downstream, causing catastrophic damage to local communities, economies, and nature.

Disturbances

Excavation blasting can trigger seismic activity, causing disturbances that result in the migration of species from a localized area.

GHG Emissions

The mining sector contributes to 4-7% of GHG emissions globally. Extracting resources, especially from deep underground or remote locations, requires heavy machinery and equipment that largely run on fossil fuels, which lead to carbon dioxide emissions. Processing raw materials is also energy intensive. The refining process can emit large amounts of GHG emissions through the use of chemical treatments and high-temperature reactions. Additionally, methane emissions may be released from underground geological formations during mining.

Freshwater Ecosystem Use

Mining can impact freshwater ecosystems through water-intensive ore processing, pollution from mine effluent, and acid mine draining. These pollutants, including heavy metals and hazardous chemicals like cyanide and sulfuric acid, harm vegetation and aquatic life. Tailings storage and riverine sand mining further compound the risks, with the potential for dam failures and habitat disturbance.

Land Use

By some estimates, mining activities have disturbed up to 1% of terrestrial land surface (an area equivalent to the size of Mongolia). Exploration and site preparation require land clearing, including deforestation and removal of vegetation and soil cover. Material extraction in open-pit and in-situ mining requires moving and re-depositing rock and soil, reconfiguring natural landscapes, and altering ecosystem functionality. Furthermore, soil erosion can lead to deterioration of surface waters and downstream ecosystems. Mining indirectly degrades habitats by increasing access to remote and biologically diverse areas, leading to higher human activity in previously remote areas that might not have otherwise occurred. Approximately 5% of operational mines and exploration sites, over 1,200 sites, are located within key biodiversity areas.

Solid Waste

Heavy metals inherent in ores can escape during leaching processes and impact vegetation and soil conditions, leading to persistent contamination. Additionally, chemical pollution arises through two key routes: the inadvertent release of processing reagents like sulfuric acid, mercury, and cyanide and the oxidation of naturally occurring minerals in ores, especially sulfides forming sulfuric acid.

Water Use

Mining and mineral processing require large volumes of water. In extraction and mining, water is used for quarrying, dust control, and on-site processing. Deep excavation requires lowering the water table, and surface mining often requires dewatering to access seams and ensure safety. Mining operations can lead to the depletion, hydraulic disturbance, and contamination of existing water resources. To process and refine minerals, activities such as milling, creating leaching solutions, ore processing, and equipment cooling are highly water intensive and require substantial water volumes.

Nature-Related Dependencies

Dependency Category	Mining	Processing	Refining
Climate Regulation	H		M
Land Stabilization & Erosion Control	M		
Water Flow Maintenance	H	M	M
Water Resources	H	M	M

Figure 24. Material nature-related dependencies across the direct operations of the metals and mining sector. Materiality ratings: VH = very high, H = high, M = medium. Low materiality ratings are left blank. Source: ENCORE.

Climate Regulation

Mining depends on stable climate patterns for operational continuity. Extreme weather events, such as floods or droughts, can disrupt operations through disturbances like reduced water availability, leading to costly delays or potential safety risks. The alteration of local landscapes through mining activities can affect microclimates, impacting temperature and precipitation patterns and ultimately affecting operational planning and site safety.

Land Stabilization and Erosion Control

Vegetated soils offer the vital service of land stabilization and erosion control, ensuring stability, preventing landslides, and reducing soil loss. Mining operations are highly dependent on effective erosion control and stabilization measures to reduce risks to operations, including disrupted operations, impacted equipment, and worker safety issues.

Water Flow Maintenance

This service is crucial for maintaining the water cycle, preventing flooding, and ensuring the availability of water for continued use in the mining extraction process.

Water Resources

Mining requires significant quantities of water for extraction, processing, and refining. Groundwater and surface water sources are often used for various processes, including ore extraction, transportation, and processing. In 2015, mining accounted for around 1% of total water withdrawals in the U.S. Water scarcity is a major barrier to the development of mineral resources.

Key Questions for Investor Engagement

- Has the company conducted an assessment to identify material impacts and dependencies, including from upstream and downstream in the value chain? Has the company identified key biodiversity areas, and are there any mining sites located within or near those areas?
- How does the company mitigate the impact of mining activities on local ecosystems and biodiversity?
- How does the company monitor and ensure the quality of water discharged back into the environment? Were there any instances of water pollution or contamination issues in the past, and how were they addressed?
- How does the company engage with Indigenous Peoples or local communities to address concerns related to land use and disruption? Are there any compensation or benefit-sharing programs in place?
- Is the company aware of any natural risks or disasters that could happen due to deteriorated landscapes (e.g., barren lands, aging dams, unstable soils)?

For water-related engagement questions, investors can refer to Ceres' Valuing Water Finance Initiative.

Related Resources

- Ceres: Global Assessment of Private Sector Impacts on Water (Valuing Water Finance Initiative)
- Ceres: Electric Vehicle Batteries: A Guidebook for Responsible Corporate Engagement Throughout the Supply Chain
- ICMM: Mining Principles and Guide to Responsible Sourcing
- International Energy Association: The Role of Critical Minerals in Clean Energy Transitions
- ResponsibleSteel: International Standard