# A Comparative Life Cycle Analysis:

## Natural Fur and Faux Fur

*Submitted to*

**International Fur Trade Federation**

*Submitted by*

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# 1 INTRODUCTION

This study was commissioned by the International Fur Trade Federation (IFTF). The natural fur industry has various public information initiatives aimed at promoting the “green” advantages of natural fur. These initiatives are based on facts; such as, natural fur is biodegradable and is not made from petro-chemicals. The industry wished to undertake a more rigourous evaluation of the life cycle demands on the environment of natural fur and faux fur. This study is in response to this need.

The practice of life cycle assessment (LCA) has advanced greatly over the last two decades. Major drivers for this development are the increased importance being given by producers and consumers to the environmental demands associated with different products and the desire of concerned consumers to purchase “environmentally friendly” products. As a result, strong market incentives have been created for producers to make environmental claims about their products. This has led to “environmentally friendly” claims being made that are difficult to substantiate or that involve “selective” assessment methodologies and analyses.

This challenge has resulted in the emergence of certification and auditing standards for “green products” associated with diverse economic sectors (e.g., forest products, organically grown produce). In parallel with these initiatives has been the demand for standardized “cradle to grave” tracking of the inputs and outputs associated with different products. LCA has emerged to provide a comprehensive accounting of the environmental demands[1] associated with different products and services.

LCA standards have been developed by the International Organisation for Standardisation (ISO). These standards have undergone several revisions since they were first introduced in the mid-1990s. Standardisation of the LCA methodology has increased objectivity and consistency, making the results more valuable for consumers and responsible producers. Both wish to ensure that environmental claims being made about products are accurate and are not misleading. The analysis presented in this report has given due regard to the ISO LCA standard with the objective being to produce a balanced and comprehensive comparison of the two products.

Coincidentally with the evolution of the ISO LCA standard, various industrial sectors, government agencies and non-government organizations have initiated LCAs and advocated LCA requirements. This has given rise to the production of extensive LCA databases, studies and reporting requirements. These initiatives have influenced and where appropriate, have been relied on for the comparative analysis reported herein.

The primary target audience for this LCA is the IFTF and its members and those considering purchasing natural or faux fur garments.

This study provides a basis for the industry to evaluate its environmental performance and for prioritizing potential areas for improvement. This type of use for an LCA is emerging as one of its greatest long-term benefits. The supporting data and methodology developed as part of this study can be used by individual operations, by regional

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[1] The term “environmental demand” is used throughout this report. Every product and service we produce and every activity we undertake places demands on the environment. These demands consist of two basic types; demand for resources (i.e., inputs such as materials, energy, water) and demand to assimilate our wastes (i.e., outputs such as emissions to land, water and air). LCA is a means to systematically track and comprehensively account for these environmental demands.

industry organisations and by the industry as a whole to guide continual environmental improvement of natural fur production operations. Such use of this LCA will generate long-lasting environmental benefits for the industry.

The generic LCA framework on which this analysis is based is shown in Figure 1. The objective is to track all significant inputs and outputs associated with each stage in the production, use and disposal of each product and to evaluate the environmental demands associated with each input and output.

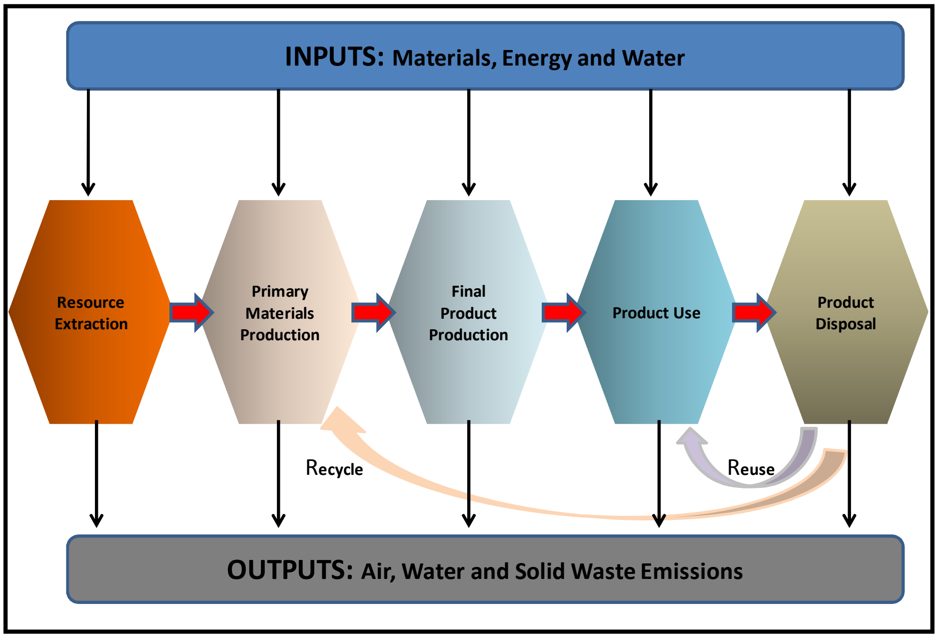


**Figure 1 - Generic Stages - Production, Use and Disposal**

All reasonable efforts were made to obtain and use the best available data. Large variations were evident among published results and among the responses received from surveys sent to various natural fur operations. In addition, considerable variation was evident among the survey data themselves. In some cases, few or no data were available for certain stages in the life cycle. As a result, the information on which this LCA is based is mix of primary data, published sources and professional judgement.

One of the major strategies for filling gaps was to rely on the SimaPro[2] software and its supporting databases (i.e., primarily the Ecoinvent[3] and the Danish LCA Food databases) and the associated generic process menu included with the software. Where a specific process associated with the production of natural or faux fur was not included, the closest facsimile was selected and modifications to the standard inputs and outputs were made consistent with the known process characteristics for the corresponding natural or faux fur process.

Resolving these gaps demanded application of professional judgement. Given that this report has been funded by IFTF, the apprehension of bias is inevitable and nowhere is this more so than where professional judgement is exercised. To reduce this apprehension, considerable effort has been made to identify clearly key situations where professional judgement has been exercised and to rationalize why a specific judgement has been reached. As well, sensitivity analysis has been used to provide an appreciation of the significance of the key judgements that have been

2 Version 7.3.0
3 Version 2.1

made. Clearly documenting data sources and explaining the related analysis allows independent review and confirmation of this analysis. In fact, this LCA has undergone a critical, independent third-party peer review as per the ISO LCA standard.

A number of LCAs dealing with one environmental aspect or another of natural fur have been undertaken (CE Delft, 2011; HSUS, 2009; Poulsen et al, 2003; van Dijk M. 2002; Smith, 1991). The IFTF has critiqued these LCAs and found a number of them wanting in various aspects. The overarching purpose of this comparative LCA is to provide technically sound, accurate and environmentally-relevant information pertaining to the environmental inputs and outputs (i.e., the environmental demands) associated with the production, use and disposal of natural and faux fur garments.

This LCA is based on the attributional LCA method[4]. The primary data collected for natural fur production is consistent with this method. The Danish LCA Food database which was used for some processes is based on a consequential LCA method. Given that this LCA largely includes only consumable inputs (i.e., energy and resources), does not include durables (e.g., building and structures), and the Danish LCA Food database was used for only two inputs (i.e., fish and poultry by-products), this methodological inconsistency does not affect significantly the results of this LCA.

# 2 *LCA PARAMETERS*

The scope of this LCA is limited to the production, use and disposal of natural and faux fur garments. All major inputs and outputs associated with each stage have been identified and characterised in terms of the amount and nature of each.

**Functional Unit** – The functional unit used for this LCA is the lifetime use of a natural-fur, full-length coat. The useful life of a natural fur coat is assumed to be 30 years. The useful life of a faux fur coat is assumed to be 6 years. To make the two products comparable, it is assumed that five faux fur coat are required to equal the useful lifetime of one natural fur coat. The composition of natural and faux fur garments is assumed to be the same except for the type of fur used.

**Natural Fur Production** - Primary data relating to inputs and outputs were collected for various processes associated with the natural fur lifecycle. These data were obtained through surveys distributed to individual operators. The response rate to these surveys was generally low. As a result, reliance on secondary data sources was necessary in many cases.

The original intent was to develop the life cycle for a representative/typical natural and faux fur garment. In the case of faux fur, this concept was reasonably practical; faux fur is primarily produced by large integrated chemical and garment manufacturing facilities. Accordingly the population of producers is relatively small and concentrated and only small variations in production process technology exist; at least, relative to natural fur. In short, many similarities exist among the faux fur producers and the associated process technologies. This is not the case with natural fur production.

Natural fur is produced on fur farms that are relatively small compared to faux fur production facilities. As well, natural fur is produced in a number of widely dispersed jurisdictions with local conditions varying substantially from one location to another. Accordingly the population of natural fur producers is relatively large, operates under diverse environmental conditions and requirements and the operations themselves vary significantly in many respects in terms of the production process inputs and outputs.

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4 Refer to Finnveden et al (2009) for further explanation of the attributional LCA method.

The result is that the notion of a representative natural fur life cycle has limited practical relevance. For this reason, no claim is made that this LCA is based on a representative natural fur life cycle. Instead, the natural fur life cycle presented in this report is largely representative of current good management practices. As a result, the life cycle for some natural fur products will have higher demands than those indicated in this LCA. On the other hand, even better environmental performance may be achieved by some producers by improved deployment of current technology or the innovation of new techniques and practices. In summary, the results presented in this report represent the environmental performance that can be expected from well run, natural fur production processes.

**Faux Fur Production** - Faux fur fibre is produced from petro-chemicals as part of large integrated chemical manufacturing facilities. Europe, Japan and North America account for much of the annual global production. Considerable investment in lifecycle inventories has been made by Plastics Europe to characterise the petro-chemical processes associated with a great diversity of products; these data are included in the Ecoinvent database[5] produced by the Swiss Centre for Life Cycle Inventories. The extent to which these data are representative of faux fur fibre production in regions other than Europe was not assessed.

Considerable processing is required to convert acrylic fibre into faux fur fabric. No systematic quantitative characterisation of these processes was found. Further, the actual production of faux fur fabric often occurs quite distant from where the fibre is produced; for example, China is a major producer of faux fur fabric. For these reasons, the faux fur fabric production processes were characterized largely by using the most comparable process included in the SimaPro generic process menu and modifying the inputs and outputs in accordance with other published sources.

**Garment Production** – The production of natural and faux fur garments was assumed to be largely comparable. The only significant difference was the nature and amount of production waste. The Ecoinvent database was used to characterise the garment production stage for both natural and faux fur garments.

**Use and Disposal** - The Ecoinvent database was also used extensively to characterise the use and disposal stages for both natural and faux fur garments.

**Inputs** - All identified inputs of materials and energy were included for both products. The Ecoinvent database includes explicit allocation and cut-off rules. These rules were accepted without modification as being appropriate for this analysis. The environmental demands associated with durable inputs (e.g., buildings, machinery, etc.) are not included; only consumable inputs and outputs (e.g., energy, process materials, wastes, etc.) are included in this LCA. The reason is that proportional to consumable inputs, the environmental demand of durable inputs is much less and is not expected to change the results significantly.

The effect of these allocations and rules is that essentially all significant inputs and outputs associated with producing inputs used directly in the production of natural and faux fur products and inputs and outputs associated with managing outputs (e.g., wastewater treatment, landfill) are included in this LCA.

**Outputs** - The Ecoinvent database was also used for tracking the environmental demands associated with managing the outputs from the production, use and disposal of natural and faux fur products. In other words, the tracking of outputs associated with the production, use and disposal of natural and faux fur products was characterised using a similar approach as was used for process inputs.

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[5] Weidema B., Hischier R., Althaus H.-J., Bauer C., Doka G., Dones R., Frischknecht R., Jungbluth N., Nemecek T., Primas A. and Wernet G. 2009 Code of Practice. Final report ecoinvent data v2.1 No. 2. Swiss Centre for Life Cycle Inventories, Dübendorf, CH. http://www.ecoinvent.org/fileadmin/documents/en/02_CodeOfPractice_v2.1.pdf

**Impact Assessment** - Impact assessment involves connecting specific environmental demands (be that resources that are consumed/extracted from the environment or wastes that are discharged to the environment) with the environmental consequences that result from these demands. In a conventional environmental impact assessment analysis, some form of "dose/response" or "cause/effect" model would be used to forecast these impacts. Such models typically are tailored to deal with the specific environmental circumstances under which production activities occur. With LCA, impact assessment is more generic and less site-specific. The objective is not to derive precise estimates of environmental impacts but rather to provide approximate indicators of the magnitude and significance associated with broad impact categories.

The Impact 2002+ impact assessment method was the primary method used in this LCA. The ReCiPe impact assessment method was used for sensitivity analysis. Both of these methods are included as part of the SimaPro software; indicator values using each method are automatically calculated by the software. Each of these methodologies has its strengths and weaknesses; most of which have been reviewed extensively in the LCA literature. These two impact assessment methods reasonably represent the current state of the art in LCA.

Impact 2002+ includes four endpoint indicators, namely:

1. Human health impacts,
2. Ecosystem quality impacts,
3. Climate change impacts, and
4. Demand on resources supplies.

These four endpoints cover the primary sustainability issues associated with these two products and provide a good basis to compare the environmental demands of the two products.

Various intermediate midpoint indicators comprise each endpoint indicator. The midpoint indicators for each Impact 2002+ endpoint are as follow. These midpoint indicators were also analysed for the two products.

**Health Impacts:**

1. Carcinogens
2. Non-carcinogenic toxins
3. Respiratory organics
4. Respiratory inorganics
5. Ionizing radiation
6. Ozone layer depletion
7. Photochemical oxidation

**Ecosystem Quality Impacts:**

1. Aquatic ecotoxicity
2. Terrestrial ecotoxicity
3. Terrestrial acidification
4. Aquatic acidification
5. Land occupation

**Climate Change Impacts:**

1. Global warming potential

**Demand on Resources Supplies**:

1. Non-renewable Energy Demand
2. Mineral Extraction

# 3 LIFE CYCLE DEMAND –NATURAL FUR

Figure 2 shows the flow of inputs and outputs associated with the life cycle of a natural fur coat. For each stage, all of the major inputs and outputs are identified and the associated quantities estimated.

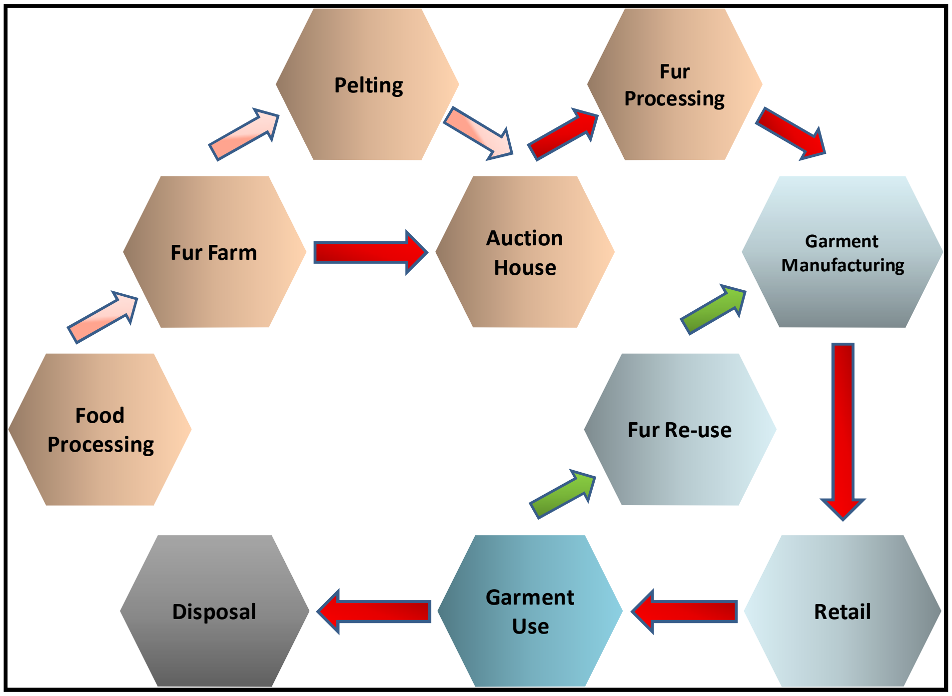


**Figure 2 - Production, Use and Disposal Stages – Natural Fur**

The red arrows indicate the primary flow path among the process stages. The pink shaded arrows indicate operations that may occur as part of an integrated mink farm operation or that may take place off-site[6]. The green shaded arrows indicate the potential for some of the product waste flow to be re-used.

The natural fur used to produce a natural fur coat in this LCA is assumed to come wholly from a commercial fur farm. This LCA does not include fur produced by the trapping of wild mink.

Figure 3 shows the proportional environmental demands associated with the entire life cycle from cradle to grave of a natural fur coat. The environmental demand for each major stage is shown in the bottom left corner of each box as a percentage of the total environmental demand for the entire life cycle. This figure shows the 6 most significant nodes (i.e., process stages) out of a total of 2077 associated with the production, use and disposal of a natural fur coat.

The major portion of the demand is associated with production of a natural fur coat (i.e., 49%). The annual storage of a natural fur coat accounts for the next largest share of the total environmental demand (i.e., about 30%). Retailing and dry cleaning combined account for about 21% of the demand. Reuse of old fur coats reduces the environmental demand by about 5%.

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[6] For the purposes of this comparative LCA, all of these processes are assumed to occur at separate sites and allowance is included for transportation of the materials from one location to another.

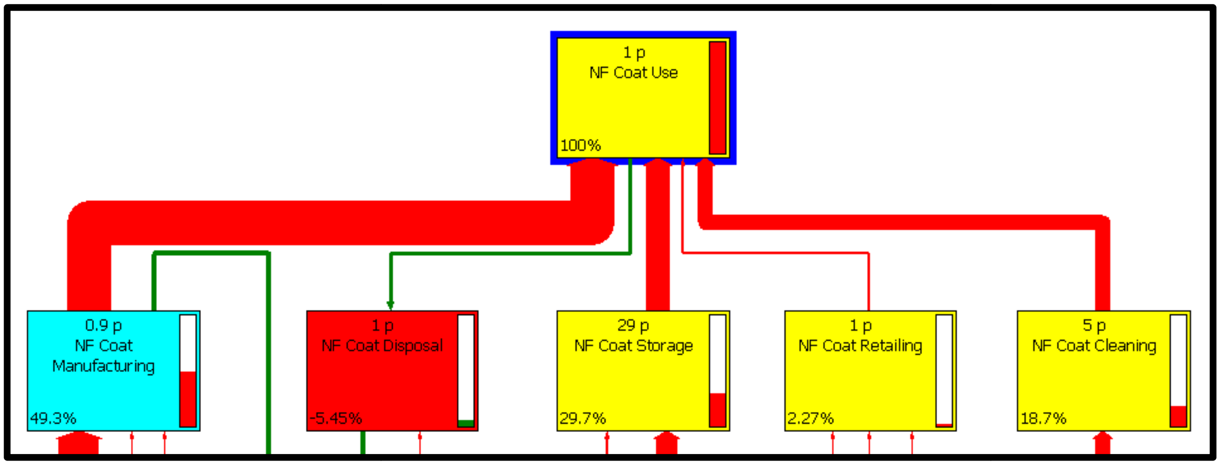


**Figure 3 – Overall Environmental Demands for Natural Fur Life Cycle**

# 4 LIFE CYCLE DEMAND – FAUX FUR

Figure 4 shows the flow of inputs and outputs associated with a faux fur coat. For each stage, all of the major inputs and outputs are identified and the associated quantities estimated.

Figure 5 shows the environmental demands associated with the entire life cycle from cradle to grave of the life cycle of a faux fur coat. The environmental demand for each major stage is shown in the bottom left corner of each box as a percentage of the total environmental demand for the entire life cycle. This figure shows the 13 most significant nodes (i.e., process stages) out of a total of 2017 associated with the production, use and disposal of a faux fur coat.

The production of the faux fur coat accounts for the largest share of the total environmental demand (i.e., over 85%). Retailing and dry cleaning account for most of the remaining environmental demand (i.e., 13%). Disposal accounts for less than 1% of the total demand and is not shown on Figure 5.

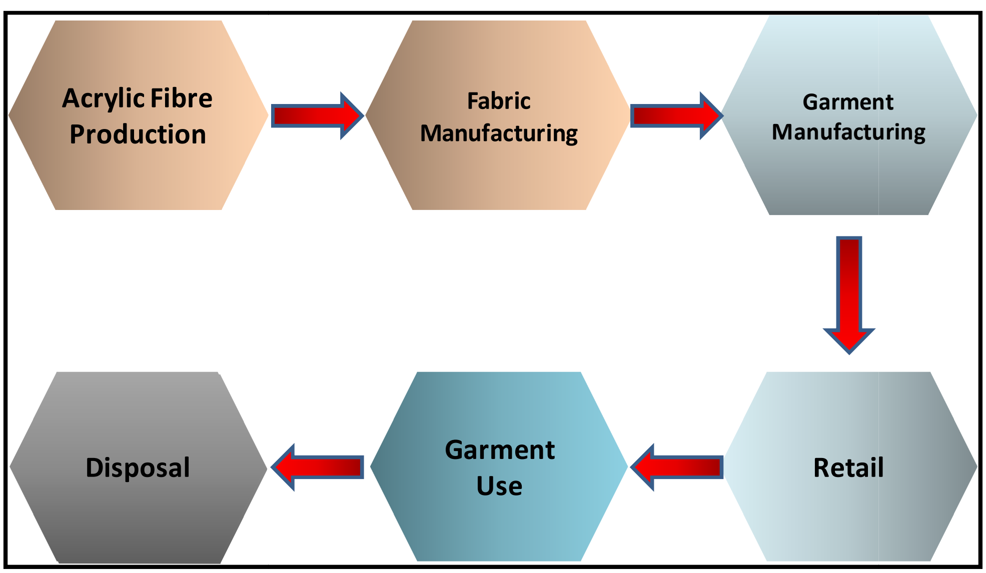


**Figure 4 - Production, Use and Disposal Stages – Faux Fur**

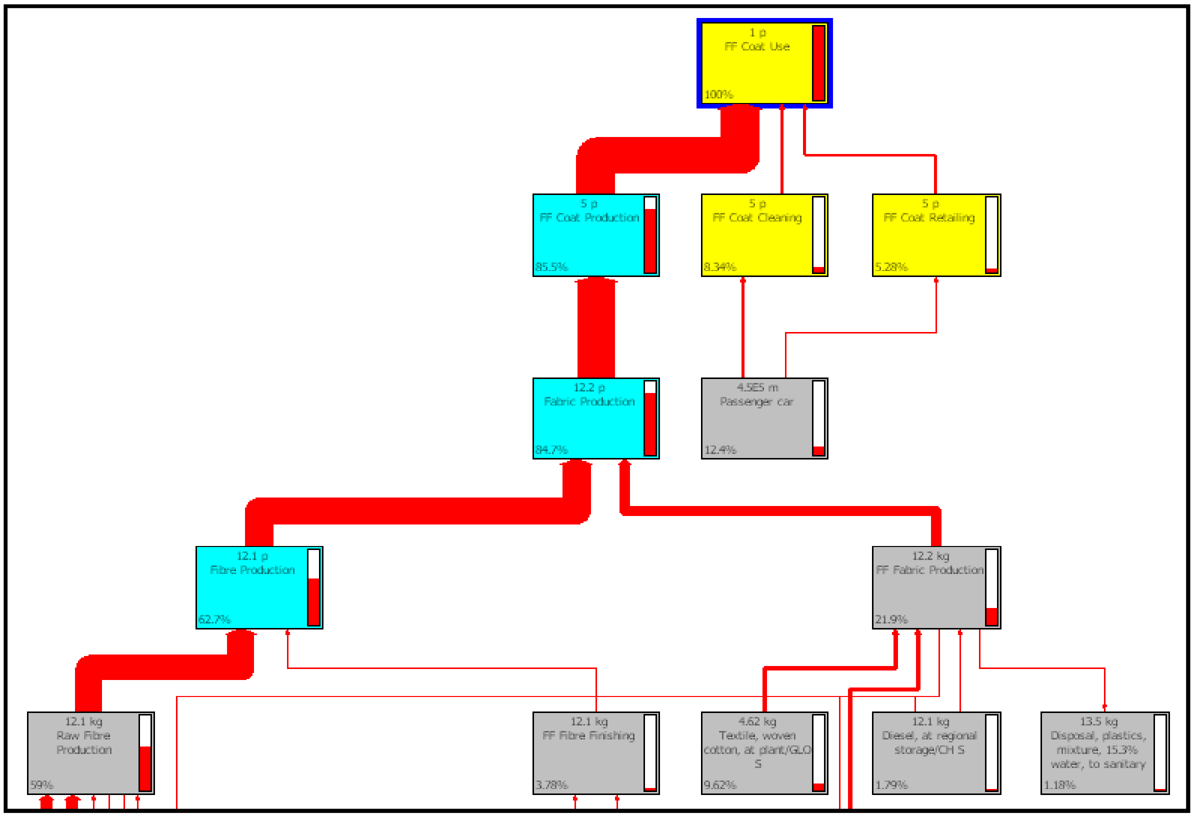


**Figure 5 – Overall Environmental Demands for Faux Fur Life Cycle**

# 5 *COMPARATIVE ASSESSMENT*

These individual life cycle assessments for natural and faux fur were used to compare the environmental demands of the two products. Figure 6 shows the environmental demand of each product in terms of individual midpoint indicators. Table 1 shows the relative differences between the two products for each indicator as a percentage of the natural fur score for the indicator.

Out of the thirteen midpoint indicators with non-zero scores, a faux fur coat scores significantly better for three indicators, namely, respiratory organics emissions, ozone layer depletion and terrestrial acidification/nutrification. On the other hand, the life cycle of a faux fur coat results in considerably greater consumption of non-renewable energy, greater risk of potential impacts of global warming and greater risk of potential impacts from ionizing radiation. As well, there is greater risk of potential impacts from carcinogenic and non-carcinogenic emissions and greater risk of potential terrestrial ecotoxicity impacts with the life cycle of a faux fur coat.

An environmental credit associated with avoided land occupation is present only with the life cycle of a natural fur coat. As a result, the life cycle of a natural fur coat reduces the potential impacts of land occupation by 2.2 times compared to the life cycle of a faux fur coat.

These results indicate that based on the environmental demands associated with the entire life cycles of the two products, a faux fur coat is expected to result in greater environmental demands than the production of natural fur coat with respect to the majority of these midpoint indicators.

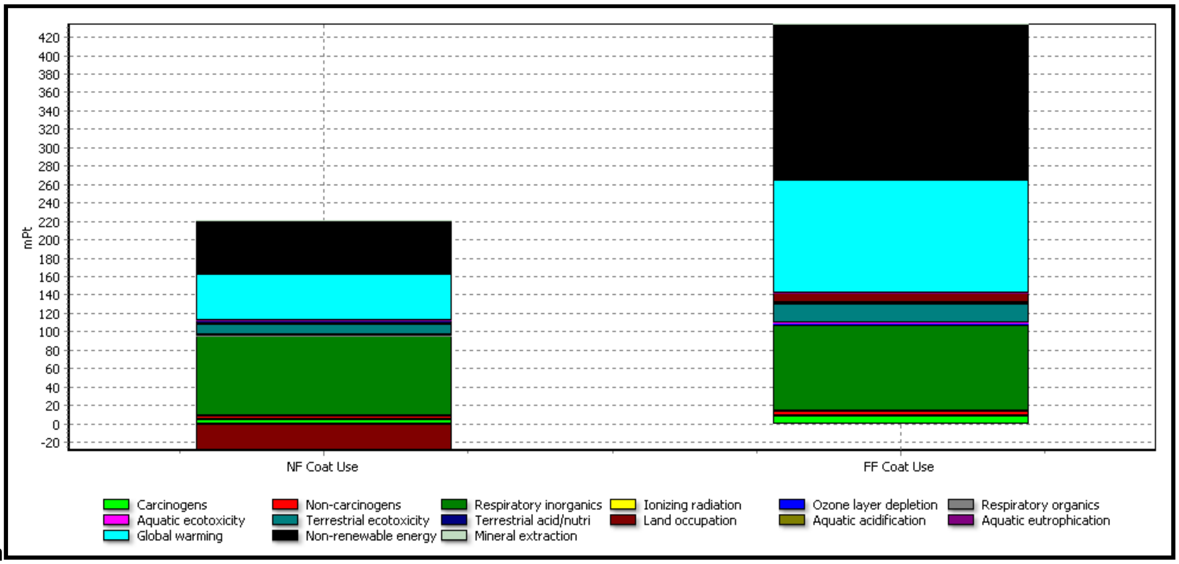


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**Figure 6 – Midpoint Scores; Environmental Demands for Overall Life Cycle**

**Table 1 – Life Cycle Scores and Percent Differences for Individual Midpoint Indicators**

| Impact Category | Raw Score[7] | | Percent Difference[8] |
|---|---|---|---|
| | Natural Fur | Faux Fur | |
| **Carcinogens** | 4.096 | 7.960 | **94%** |
| **Non-carcinogens** | 3.932 | 5.200 | **32%** |
| **Respiratory inorganics** | 86.971 | 84.131 | **-3%** |
| **Ionizing radiation** | 0.246 | 1.159 | **370%** |
| **Ozone layer depletion** | 0.065 | 0.040 | **-39%** |

[7] All scores are reported in 'millipoints' units. Millipoints is an abstract unit used to express diverse types of potential impacts. Refer to the Impact 2002+ website for further details. University of Michigan Risk Science Center - Risk and Impact Modeling - Research - Impact 2002+

[8] The percentage differences are calculated by dividing the difference between the natural and faux fur scores and dividing by the natural fur score for the indicator.

| | | | |
|---|---|---|---|
| **Respiratory organics** | 0.408 | 0.305 | **-25%** |
| **Aquatic ecotoxicity** | 0.561 | 0.571 | **2%** |
| **Terrestrial ecotoxicity** | 12.017 | 16.874 | **40%** |
| **Terrestrial acidification /nutrification** | 4.312 | 1.880 | **-56%** |
| **Land occupation** | -28.759 | 4.503 | **116%** |
| **Global warming** | 49.576 | 113.451 | **129%** |
| **Non-renewable energy** | 58.384 | 156.969 | **169%** |
| **Mineral extraction** | 0.050 | 0.056 | **12%** |

Figure 7 evaluates the two products based on their impact on four endpoint indicators, namely human health, ecosystem quality, climate change and consumption of resources. The scores for each of these endpoint indicators are derived from the more detailed midpoint indicators discussed above. Table 2 provides the specific scores for each endpoint indicator.

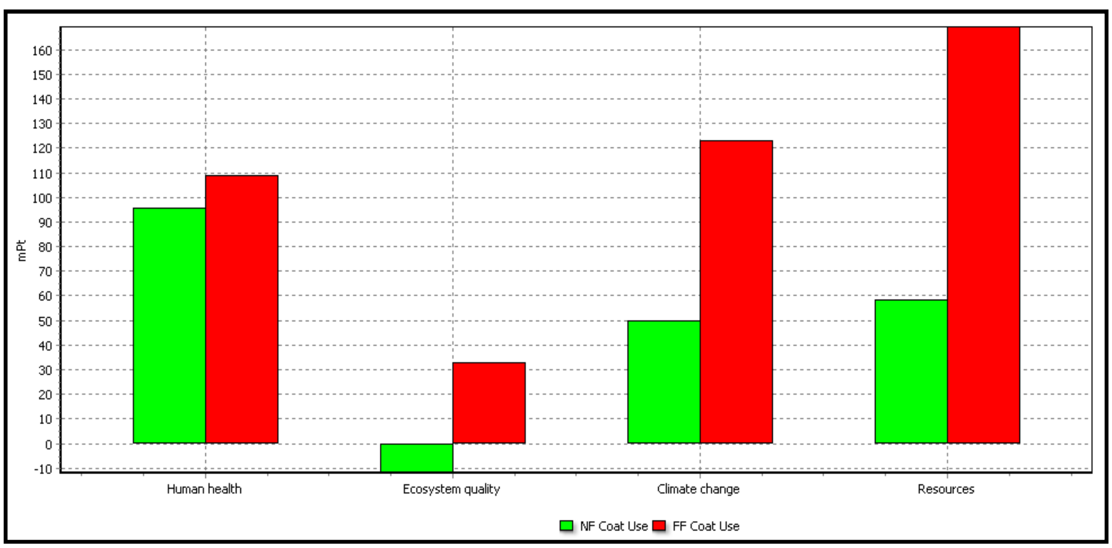


**Figure 7 – Endpoint Indicators Scores for Natural and Faux Coat Life Cycles**

**Table 2 – Life Cycle Scores and Percent Differences for Individual Endpoint Indicators**

| Endpoint Impact Category | Raw Score | | Percent Difference |
|---|---|---|---|
| | Natural Fur | Faux Fur | |
| **Human Health** | 95.7171 | 98.7944 | **3%** |
| **Ecosystem Quality** | -11.8683 | 23.8284 | **-301%** |
| **Climate Change** | 49.5762 | 113.4507 | **129%** |
| **Resources** | 58.4343 | 157.0249 | **169%** |

The life cycle of a faux fur coat poses 3% more risk for potential adverse human health impacts than a natural fur coat. Most of the human health risk with a natural fur coat is associated with coat production (i.e., 70%), storage (i.e., 19%) and cleaning (i.e., 12%).

The life cycle of a faux fur coat poses four times more risk for potential adverse impacts on ecosystem quality than a natural fur coat. Natural fur coat production yields benefits in terms of ecosystem quality through reductions in land occupation and reduced emissions of associated with inorganic fertiliser production. The opposite is the case with the production of a faux fur coat; 75% of the risk to ecosystem quality associated with a faux fur is related to coat manufacturing.

The life cycle of a faux fur coat poses 2.3 times more risk for potential adverse impacts from climate change than a natural fur coat. Production of faux fibre and fabric account for 78% of the climate change risk associated with that product.

The life cycle of a faux fur coat poses 2.7 times more risk for potential adverse impacts on resource consumption than a natural fur coat. Production of faux fibre and fabric accounts for 90% of the resource consumption risk.

On the basis of these four endpoint indicators, a natural fur coat outperforms a faux fur coat. However, the actual environmental performance of any product is sensitive to site-specific conditions that are not captured by broad indicators such as these. As well, these indicators do not capture all environmental risks associated with either product. For these reasons, a categorical statement that one product is superior to another cannot be made.

These results do indicate however that the production of a product like natural fur that is derived from an agricultural production system using byproducts from food processing systems if done carefully, does have advantages over the production of goods that fundamentally depend on non-renewable resources. The challenge for the fur industry is to examine critically their production cycle and to seek ways to improve the production system so that the environmental performance of natural fur will be even better in the future. This LCA provides helpful guidance as to where the greatest improvements may be possible.

# 6 SENSITIVITY ANALYSIS

LCA invariably involves data/information gaps and uncertainties. Judgements and assumptions must be used to overcome these deficiencies. Every effort has been made to make the best judgements and assumptions possible. Nonetheless, these assumptions are sources of uncertainty that can influence the results of an LCA. The sensitivity of the projected environmental demands to some of the more significant factors that influence the results has been analysed. This sensitivity analysis deals with only a limited set of combinations of parameters; indeed, the potential number of sensitivity analysis combinations is practically infinite, particularly if multiple parameters are varied simultaneously. Nonetheless, even though the scope of this sensitivity analysis is limited, the results provide useful insights into the importance of certain key parameters and assumptions in this LCA.

For the purposes of this sensitivity analysis, key parameters have been identified; for each parameter, a potential high and low value has been estimated. Each of these values has been analysed individually and the results reported. No sensitivity testing for multiple parameters being changed simultaneously has been undertaken.

**Functional Unit** – A key parameter that affects all aspects of this LCA is the functional unit (i.e., the length of the useful life of a natural fur coat). The peer reviewers identified this parameter in particular as being of key importance. Two variations are analysed. The first is an increase in the useful life of a faux fur coat from six years to eight years. The second change is increase in the useful life of a natural fur coat from 30 years to 36 years.

Extending the faux fur life to eight years reduces the associated environmental demands equally among the four endpoint indicators by 20%. This sensitivity adjustment causes the preference order for one of the four endpoint indicators, namely human health, to change in favour of faux fur. The risk of potential human health impacts from the life cycle of faux fur is reduced from being 3% greater than that associated with the life cycle of a natural fur coat to being 17% less. The differences between the two products for the other three endpoint indicators remain quite significant (i.e., the difference in ecosystem quality risk increases is 3.6 time greater with faux fur; 83% higher for the risk of climate change; almost 2.1 times greater for resource consumption risks).

Increasing the useful life of a natural fur coat also does not affect the preference order for the four endpoint indicators; a natural fur coat is still preferred for all of the four endpoint indicators; however, its environmental advantages are greater (i.e., the difference in human health risk increases from 3% to 16%; the climate change and resource consumption risk difference increase by 18% and 26%, respectively; the difference in ecosystem quality risk increases by 85%.

These results show that the results of this LCA are more sensitive to the useful life of a natural fur coat than a faux fur coat. Even so, the preference order among the endpoint indicators is fairly stable with the exception of the human health endpoint indicator.

**Summer Storage** – Assumptions regarding summer storage of natural fur coats have relatively large environmental consequences. A key assumption is that every natural fur coat is shipped off site each year for cold storage during the warm months of the year. This assumption is recognized as being an overestimate that inflates the environmental demands associated with a natural fur coat. The impact of decreasing the number of fur coats sent to off-site storage was examined. More specifically, it is assumed that 50% of the natural fur coats are sent annually to off-site storage and 50% are stored in the consumer's home.

This change resulted in significant improvements in the environmental performance of natural fur coats. The greatest improvements were related to the reduced risk of potential impacts associated with resource consumption and climate change (i.e., 44% and 46% improvement relative to the base case). The risk of potential human health impacts is reduced by 11%. The risk of potential impacts on ecosystem quality risk is reduced by 23%. These results provide an indication of the magnitude of the impact on the LCA results by assuming all natural fur coats are shipped off-site for storage.

**Re-use Proportion** – Another key assumption is that 10% of the natural fur coats are re-used. Two alternate possibilities were analysed; namely, no re-use (i.e., 0%) and 20% re-use. Eliminating re-use changes the differences between the two products slightly in favour of a faux fur coat.

Eliminating natural fur re-use increases the risk of potential impacts for three indicators. The difference for human health impacts switches from 3% greater for a faux fur coat to 7% less. The differences in the risk of potential impacts associated with resource consumption and climate change are reduced by 15% and 11% respectively. On the other hand, the difference in the risk of potential impacts on ecosystem quality is increased by 20% due to environmental credits associated with fur production. Overall, a natural fur coat is preferred for three out of the four endpoint indicators with no re-use.

Increasing the re-use fraction to 20% results in essentially the opposite outcome to eliminating re-use. The difference in the risk of potential human health impacts increases from 3% to 11%. The differences in the risk of potential impacts on climate change and resource consumption increase by 12% and 17%, respectively. The difference in the risk of avoided potential ecosystem quality impacts decreases by 20%.

In summary, eliminating re-use or increasing re-use only changes the preference order for the human health endpoint indicator.

**Feed Ration Proportions** – One of the key inputs to mink production is the feed ration. Two sensitivity tests were analysed. First, the quantity of feed required to sustain a harvestable mink was varied. Second, the proportions of fish and poultry waste used in mink feed were varied.

The feed ration amount assumed in this LCA is considerably higher than that reported by other researchers and is more likely to be an over-estimate as opposed to an under-estimate. The assumed feed ration for a harvestable mink is 63.4 kg. For sensitivity testing, the value reported by Poulsen (2003) has been used (i.e., 36.62 kg/harvestable mink).

Reducing the quantity of feed needed to sustain a mink affects all four endpoint indicators significantly. The difference in the risk of potential impacts increases for three endpoint indicators; namely, the differences in the risk of potential human health, climate change and resource consumption impacts are increased by 31%, 29% and 29%, respectively. On the other hand, the risk of potential impacts on ecosystem quality is decreased by 95% relative to the base case. Even so, a positive environmental credit remains. Overall, reducing the mink feed ration does not change the preference order for any of the endpoint indicators and increases the environmental advantages of natural fur for three of the four endpoint indicators.

Changing the proportions of fish and poultry in the mink feed has the greatest effect on the differences among the endpoint indicator scores. The difference in the risk of potential impacts on human health switches from 3% in favour of a natural fur coat to 24% in favour of a faux fur coat. A natural fur coat is preferred in relation to the other three endpoint indicators but the differences are reduced for all of these indicators. The ecosystem quality indicator no longer shows an environmental credit; although a natural fur coat is still preferred by a difference of 30%.

Both the amount of feed consumed by mink and the proportions of the byproducts used to produce mink feed have a significant impact on the LCA results. In particular, the nature of the byproducts used to produce the feed and their alternate management in the absence of demand by mink producers are important considerations when evaluating the environmental performance of natural fur.

**Impact Assessment Method** – Impact assessment methods are used to assist with interpreting the results of a life cycle inventory. Different assessment methods involve different assumptions about the environmental risks associated with different combinations of inputs and outputs. The sensitivity of the results to using an alternate impact assessment methodology (i.e., the ReCiPe method) was analysed.

The ReCiPe impact assessment methodology scored a natural fur coat as being environmentally superior for all three of its endpoint indicators and by a substantially higher margin than was the case with the Impact 2002+ method. The ReCiPe impact assessment methodology scores a natural fur coat as being environmentally superior by 68%, 9.1 times and 2.4 times better for human health, ecosystems and resources, respectively. For this reason, it is concluded that these comparative results are not exaggerated by the impact assessment that has been used.

# 7 CONCLUSIONS AND RECOMMENDATIONS

The life cycle of a natural fur coat tends generally to outperform that of a faux fur coat based on the data and assumptions used in this LCA. Nonetheless, a categorical conclusion cannot be reached that one product is superior environmentally in all respects to the other due to the limitations of the data and LCA method in general. The data and assumptions used in this LCA lead to the conclusion that in general, the life cycle of faux fur coat results in greater risk of potential impacts associated with ecosystem quality (i.e., 300% greater), resource consumption (i.e., 169% greater) and climate change (i.e., 129% greater). The difference between the two products with respect to the risk of potential impacts on human health is negligible (i.e., 3% greater for a faux fur coat). A number of environmental credits (i.e., benefits) are associated with the life cycle of a natural coat. These benefits accrue in particular to natural ecosystems. The life cycle of a faux fur coat does not yield any environmental credits.

Two key sources of environmental demand associated with natural fur are the nature and quantity of mink feed and the proportion of coats shipped off site for summer storage; in particular, the primary purpose of passenger car trips to the storage facility and the proportion of natural fur coats shipped to an offsite storage facility. Considerable variation in these parameters is known to be present; as a result, determining representative values for each is of questionable practical use, ignoring the methodological challenges.

From a fur industry perspective, mink feed rations are continually being improved and these improvements will largely yield improvements in the overall environmental performance of natural fur. Much less potential exists to improve the environmental performance of faux fur. The potential for significant efficiency gains in the production of synthetic materials like faux fibre is becoming less and less. For this reason, the life cycle demands of faux fur are less likely to diminish over time compared to those associated with natural fur. By closing the loop in natural fur production, considerable further improvements are possible.

In principle, the data quality on which this LCA is based could be improved by conducting in-person surveys of individual operations. The advantages of an improved database need to be weighed against the costs of such an endeavour. This LCA provides a framework for the integration of future data as they come available. Furthermore, the results of this LCA provide a reasonable first approximation of the environmental demands of the two products.

Further insights can be gleaned most economically with the current database by conducting additional sensitivity analyses. For this reason, future investments in improving the accuracy and comprehensiveness of the database should be made only where important decisions need to be made that will benefit significantly from improved data. Wider ranging and more complex sensitivity analyses should be undertaken when a specific question or decision arises relating to the environmental demands of natural fur. The analytical framework on which the LCA model for natural fur is founded provides a ready means for the fur industry to explore alternative means to improve their environmental performance.

This LCA offers the potential for the fur industry to adopt a continual improvement management system for its constituents. Doing so will involve developing and adopting reporting protocols, good management practices and related measures. Consideration should even be given to developing a seal of approval or eco-labelling system for certifying that natural fur has been produced according to industry best practices. This type of initiative would be an excellent complement to the industry's efforts to promote its environmental performance attributes. This LCA provides many of the building blocks needed to initiate such a program.

The LCA models developed for this analysis use the SimaPro software. Considerable effort has been invested in developing these models and entering the relevant data for each process. These models include all stages of the production, use and disposal of the two products. Once a basic life cycle model has been is constructed, detailed analyses of individual processes and even individual operations can be performed with relative ease. The fur industry should maintain the natural fur LCA model and update it from time to time. This system will be valuable for supporting industry claims and for informing individual operators in terms of how they might improve their environmental performance.

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