DEEP-DIVE ANALYSIS ON UNITED STATES COTTON PRODUCTION IMPACTS ON BIODIVERSITY, ECOSYSTEMS, AND LAND

REPORT

EXECUTIVE SUMMARY

Transforming the Fashion Sector with Nature is a two-year project funded by the Global Environment Facility (GEF). Conservation International, a GEF Agency, is partnering with The Fashion Pact to work together in executing this project. By using world-class science, this project aims to better understand and mitigate the fashion industry's impact on biodiversity.

Under this project, deep-dive analyses were conducted by Conservation International, along with the International Union for Conservation of Nature (IUCN), Natural Capital Coalition, and the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC), applying the current Science Based Targets for Nature (SBTN) metrics for land, ecosystem services, and biodiversity to understand the associated impacts of three key commodity supply chains: **cotton in the United States, leather in Argentina, and viscose in Austria and Indonesia.**

This deep-dive analyses included three metrics, Species Threat Abatement and Restoration (STAR), Ecosystem Integrity Index (EII), and the SBTN Land Hub Impact Indicators (Land Hub Indicators). Each metric modeled a variety of interventions. The STAR metric quantifies the potential opportunity to reduce the risk of species extinction and identify conservation and restoration actions. STAR modeled an intervention for conversion to organic farming practices. The EII measures the alignment between the area of interest and its natural ecosystem counterpart. EII modeled interventions for conversion to organic farming practices and riparian protection. The SBTN Land Hub Impact Indicators are focused on developing targets for land systems, in both natural and working lands. Using a cotton-specific impact factor the Land Hub Indicators modeled the conversion to organic farming practices.

Based on these analyses, summary reports were produced for each commodity to support companies looking to set science-based targets for nature and to identify opportunities to strengthen actions and investments for biodiversity and nature-positive outcomes. This report focuses on the findings and recommendations for cotton in the United States; the other reports can be found here.

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KEY FINDINGS AND RECOMMENDATIONS

Findings from the analyses detail how cotton production impacts biodiversity in the United States. Results range from identifying the top threats to threatened and endangered species, the changes to ecosystem integrity if scenarios for organic farming practices and riparian protection are implemented, and production impacts on land such as vegetation and carbon loss. These findings can help companies better understand their direct and indirect impact from sourcing locations and prioritize actions to abate or alleviate the effect on sensitive regions or species.

The **key recommendations from the deep-dive analysis** on cotton production underscore the importance of:

1.) establishing supply chain traceability to suppliers at a minimum;

2.) working with suppliers to understand and/or establish traceability commitments; and

3.) aligning company commitments and targets with global standards.

For the purposes of this report, we focused on road-testing these metrics, but these are not the types of scientific steps a company must take. Companies should follow the corporate-friendly guidance from SBTN.

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INTRODUCTION

The Fashion Pact, a global initiative composed of companies in the fashion and textile industry, has committed to transforming the fashion sector to improve sustainability performance across the entire sector. The Fashion Pact focuses on driving change in three areas: climate, biodiversity and oceans.

With support from the Global Environment Facility (GEF), Conservation International and The Fashion Pact launched Transforming the Fashion Sector with Nature, a project that focuses on using science to better understand and mitigate the fashion industry's impact on biodiversity. Through this initiative, we aim to 1) provide companies across the fashion sector with a foundational understanding of the environmental impacts of the production and extraction of raw materials through deep-dive analyses on key production areas for cotton, leather, and viscose; and 2) support companies across these supply chains to identify opportunities for further action, investment, and collaboration through a scenario analysis of potential interventions and outcomes. Together, these outputs can help fashion companies prioritize actions that can have the greatest impact for biodiversity.

This report is one of the primary outputs of the first objective to produce a deep-dive analysis of environmental impacts of cotton production in the United States. This report uses country-level data to assess biodiversity, land and ecosystem metrics in cotton producing regions. Companies can use this study to better understand their exposure to the potential environmental impacts of their supply chain and inform company commitments and actions to protect, restore or regenerate nature in key producing regions. This report is structured not only to provide more information for companies on key commodities, but also to demonstrate the types of analyses that are possible. The process and tools being built for supply chain analyses are equally as important as the results and recommendations they yield.

METHODS

One of the goals of the Transforming the Fashion Sector with Nature GEF project is to align corporate actions with The Science Based Targets Network (SBTN), a collaboration of organizations developing guidance to support companies and cities in setting science based targets for land, freshwater, oceans, and biodiversity. As the biodiversity pillar's delivery partner, Conservation International seeks to provide sector-specific guidance for how companies across the fashion and textile industry can apply the developing methods of the SBTN, how those methods can inform corporate sustainability commitments and targets, and the utility of the methods and metrics in measuring the impacts of corporate actions.

In this analysis, Conservation International along with the International Union for Conservation of Nature (IUCN), and the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) conducted a series of deep-dive analyses applying the current SBTN metrics for land, ecosystem services, and biodiversity to cotton supply chain in the United States. The USA is the third largest producer of cotton and provides 35% of global cotton exports.[1]

The study area was defined by cotton producing regions in the United States (Figure 1). To spatially identify cotton areas, we used a 30-meter Cropland Data Layer[2] (CDL) derived by the USDA. The analyses were conducted using three metrics: the Species Threat Abatement and Restoration Metric (STAR), the Ecosystem Integrity Index (EII), and the SBTN Land Hub Impact Indicators. These metrics were applied to both baseline and intervention scenarios to understand the impacts of sustainability interventions companies are looking to make.

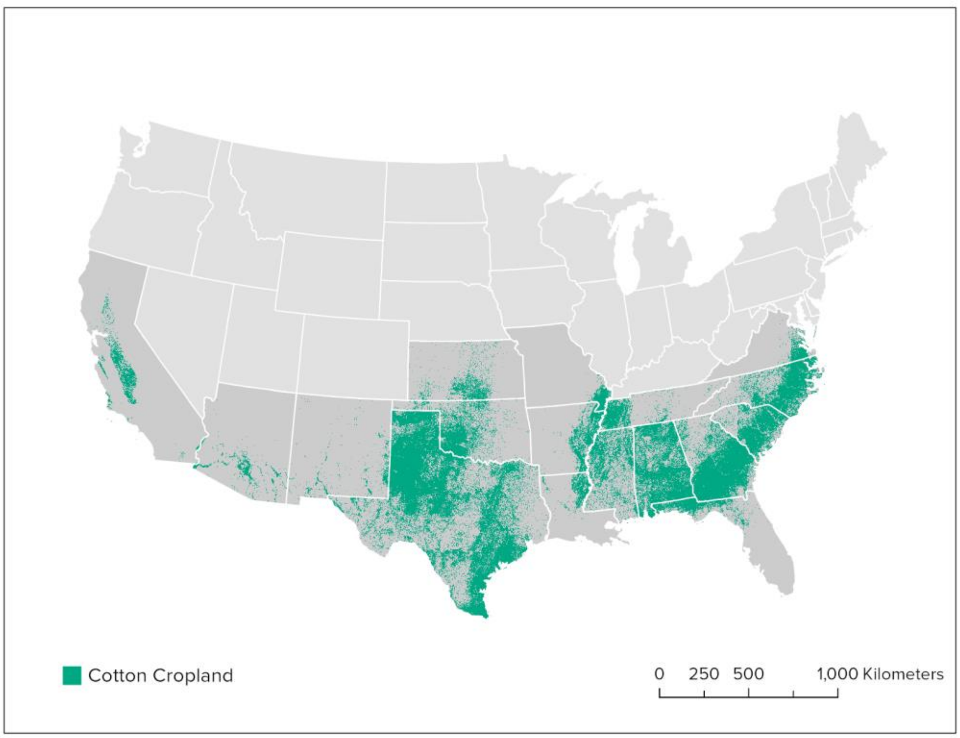

Figure 1. *This map shows US cotton production states.*

[1] https://www.ers.usda.gov/topics/crops/cotton-and-wool/cotton-sector-at-a-glance/

[2] USDA National Agricultural Statistics Service Cropland Data Layer. Published crop-specific data layer. Available at https://nassgeodata.gmu.edu/CropScape/ (accessed December 2021). USDA-NASS, Washington, DC.

STAR: Species Threat Abatement and Restoration Metric

The STAR[3] metric uses data from the IUCN Red List of Threatened Species to quantify the potential opportunity for reducing the risk of species extinction and to identify opportunities and guide conservation and restoration actions[4]. STAR is a useful metric because it can be used to identify areas where certain actions can abate threats to threatened species or where restoration can help reduce the risk of extinction. The metric currently covers amphibians, birds and mammals. The metric combines data on each resident species' range (Area of Habitat; AOH), conservation status (i.e., Near Threatened, Vulnerable, Endangered and Critically Endangered), and threats from IUCN Red List threats classification scheme (e.g., wood and pulp plantations, oil and gas drilling, agricultural and forestry effluents etc.) to produce two data layers with associated scores on the threat abatement ($STAR_T$) and restoration ($STAR_R$). High $STAR_T$ scores indicate areas where at-risk species are threatened, indicating key areas for opportunities to reduce threats. High $STAR_R$ scores indicate areas where threatened species habitats have been lost or threatened and can identify key places for restoration.

For the cotton supply chain, we reproduced the STAR metric following the methods described in Mair et al. 2021 in a manner that preserved the individual species contributions to the STAR scores. This was applied to the area of interest to assess the level of impact within the current cotton production areas, along with the potential to identify and quantify potential species threat reduction and restoration activities that can reduce species extinction risk. We calculated a score for both species and threats categories to receive an overall score for the baseline cotton production footprint and then calculated an overall score for the subsequent intervention to transition to organic production. The differences between the baseline and intervention scenarios show the potential impacts of organic cotton.

EII: Ecosystem Integrity Index

The EII[5] measures to what degree the area of interest is aligned with characteristics of natural ecosystems using a combination of geospatial layers representing three components:

- Ecosystem Composition – The Biodiversity Intactness Index (BII) summarizes how human pressures change the ecosystem by looking at the percentage of the original species population in an area compared to populations in a natural setting. The impact of human activity on species abundance and the similarity between disturbed ecological communities and their reference sites is calculated. These results are projected onto maps of human pressures (i.e., land use change, population density) to create a map of BII for the area.
- Ecosystem Structure – The structural component of EII includes habitat area, quality, and fragmentation by using multiple input layers including population density, built-up areas, agriculture, roads, railroads, mining, oil wells, and wind turbines and electrical infrastructure.

[3] IUCN STAR Metric

[4] https://doi.org/10.1038/s41559-021-01432-0

[5] https://doi.org/10.1101/2022.08.21.504707

- Ecosystem Function – This layer includes the interactions between abiotic and biotic components, which describes the ratio between the observed and natural net primary productivity (NPP) level or the rate of production of biomass per land surface. The larger the difference between the observed productivity and natural productivity, the more degradation or loss of ecosystem function.

The three components are rescaled and combined to give a score which is the minimum value from the three contributing components. The overall EII score can be used to set baselines of ecosystem health in sourcing areas and estimate potential and realized impacts from their supply chain over time.

Land Hub Indicators

The SBTN Land Hub[6] is focused on developing targets for land systems – including both natural ecosystems like forests, grasslands, and woodlands, as well as "working lands" such as pasture and agricultural and the built environment like cities and linear infrastructure. The Land Hub is therefore interested in indicators that both capture change among categories (e.g., from forest to pasture), as well as changes that might occur on land under continual use (e.g., loss of topsoil that might occur in working lands due to poor soil maintenance). To address these impacts through avoidance or reduction of impacts, regeneration, or restoration, the Land Hub identified seven indicators: 1) conversion of native vegetation (forest); 2) conversion of native vegetation (non-forest); 3) productivity; 4) soil carbon; 5) soil erosion; 6) pollution; and 7) infrastructure development. The Land Hub piloted an assessment tool (CAMEL) for an initial set of commodities including cotton. Cotton production data was used in this pilot for six of the seven indicators, as the impact factors for infrastructure development are not yet developed.

To assess the Land Impact indicators for cotton we used the cotton-specific impact factors developed by the Land Hub. Each impact factor is expressed in units that are per hectare per year (so per unit area for each year of production).

Modeled Interventions:

Two interventions were assessed in the analysis. The STAR, EII, and Land Hub Indicator metrics all modeled the intervention of transition from conventional farming to organic farming methods, which include actions such as organic pest and weed management, and crop rotation practices. Organic practices are assumed to be less intensive on the land but are also assumed to produce lower yields and therefore require larger areas for the same total production.

EII modeled the preservation or restoration of riparian areas. This action would likely impact all three components of EII by increasing the integrity of areas that contained protected rivers because of the expansion of natural habitat, which would have higher ecosystem integrity than croplands.

[6] SBTN Land Hub

LIMITATIONS

The metrics used in this analysis can provide valuable assessments to companies, especially when deciding where to prioritize efforts and identifying the impact to biodiversity. Across all the metrics , a major limitation is access to supply chain level data. In all cases, the more granular data the more accurate the analysis. Each metric has limitations and nuances that are important to note, though this list is not exhaustive of all known limitations. STAR values are directly dependent on the total area that is assessed (i.e., the larger the areas, the more species at threat) but do not consider other factors such as the production practices or the production yields. This metric is also just focused on terrestrial vertebrates (amphibians, birds, mammals, reptiles), however in many intervention cases, the species most likely to benefit the most are insects and aquatic species which are not accounted for in the metric. The limitation for EII is that it contains inputs from three different components and by using the minimum value approach, taking the lowest score of the layers for the pixel value. The ecosystem integrity score is dependent on the land modifications. In some cases, agricultural lands could receive a score that is closer to 1 (higher integrity/more natural), that mimic natural lands but in reality, do not have high ecosystem integrity. Land Impact Indicators, cotton-specific impact factor gives a more detailed level of analysis for cotton, but it is still based off the Cropland Data Layer at a 30m resolution. Since the cotton impact factor is at a higher resolution, with more granular or company specific data, the impact of cotton on biodiversity could yield more accurate results. Interventions are simply represented as estimates of actions or changes that are able to be modeled; many of the actions associated with transition to organic cotton production cannot be captured in the metrics we are testing in this report.

FINDINGS AND RECOMMENDATIONS

STAR

The baseline $STAR_T$ shows when the footprint of cotton production is smaller, it has a lower overall score versus when the footprint is expanded and more extensive it results in a higher overall $STAR_T$ score. Where the footprint expands will determine how much STAR increases, because it is based on what species reside in the area. Further, STAR highlights the top threats to species, which companies can work to reduce in their existing footprint.

Impacts

Each threat received a score based on its contributions to the $STAR_T$ score. The top threats to species in cotton production regions include livestock farming and ranching (14% of the overall STAR score), agricultural and forestry effluents (10%), and annual and perennial non-timber crops (8%) (Figure 2). Cotton production contributes to threats from annual and perennial crops and from agriculture effluents – it's not the only production system that contributes to these categories but is likely to be a significant contributor given these are intense cotton production areas.

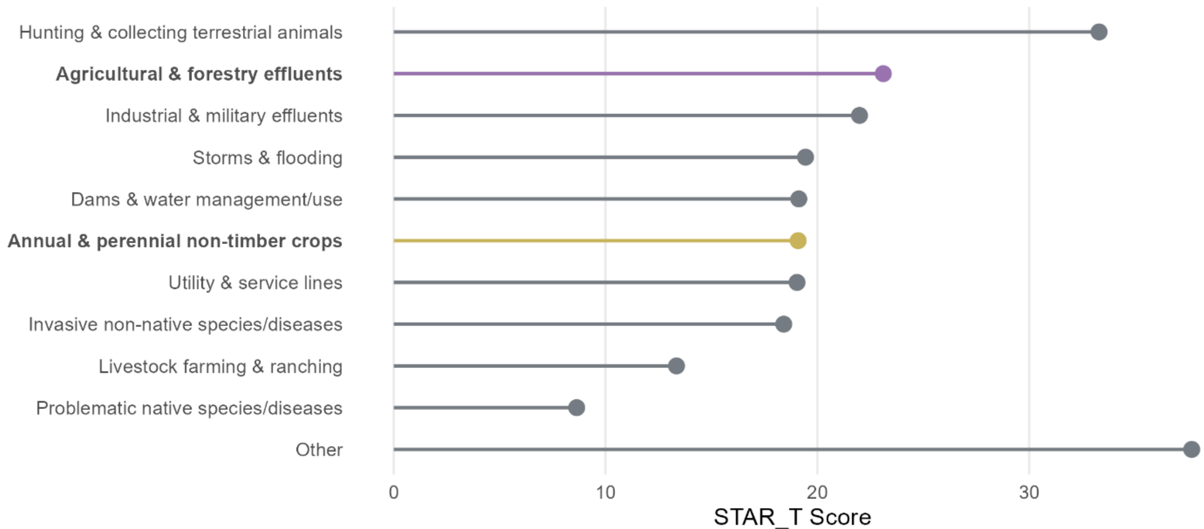

Figure 2. *Top threats from STAR whose abatement in the area would contribute the most toward reducing global extinction risk, with taxonomic counts for species within each threat category. Of the threats, cotton is directly involved in two of the top three threats to biodiversity. Note that the STAR contribution is a composite score to allow comparison of the relative threats to species within the specific study area.*

The threats most directly tied to cotton (agriculture/forestry effluents and annual and perennial non-timber crops) have impacts on several species, including many species of birds, reptiles, amphibians, and mammals (Figure 3). Some of the species at greatest extinction risk across the study area are the Georgia Blind Salamander, Tricolored Blackbird, Giant Garter Snake, and Houston Toad.

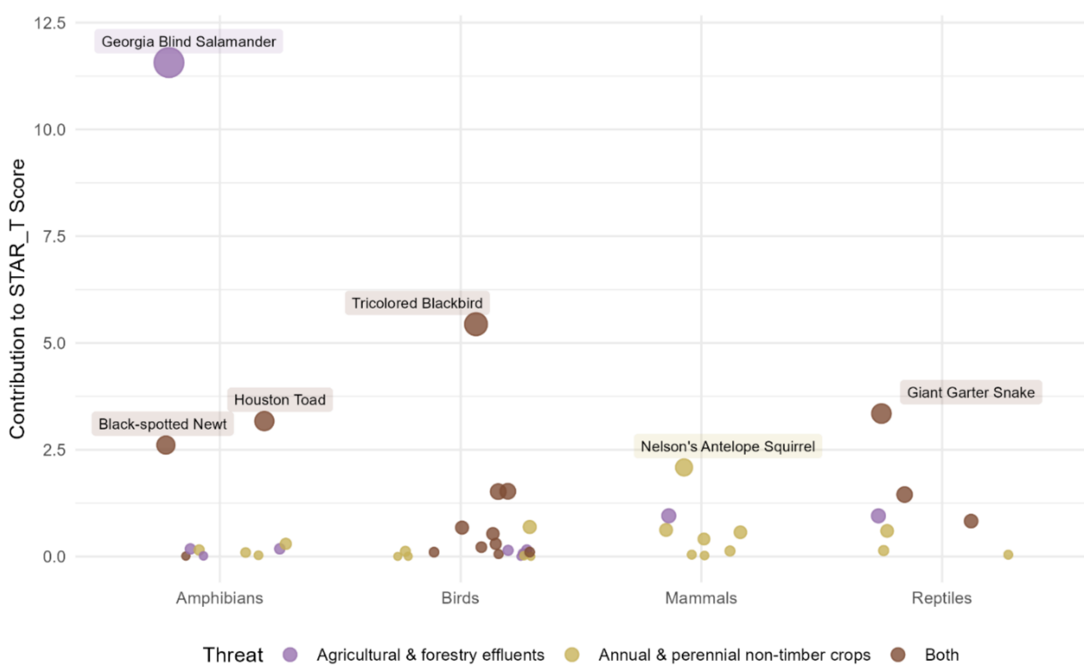

Figure 3*. Across the United States cotton production regions, the species-level contributions to the STAR Threat Abatement score, Species threatened by Annual and perennial non-timber crops and Agricultural and forestry effluents are highlighted by the colors of each bubble.*

Interventions

Organic cotton transition can potentially provide positive benefits for biodiversity as indicated by the STAR metric. In addition to the species included in the metric, there are others such as insect biodiversity[7] that can greatly benefit from transitioning to organic practices. In many cases, transitioning to organic farming practices leads to positive results; though it is only shown as positive in the metrics if the amount of land under production and the yield remains the same between traditional to organic. If a company must increase their cotton production footprint due to lower yields, the expansion of land would negate the potential biodiversity benefits measured in this report or potentially cause more biodiversity damage than without the intervention. With any supply chain, there are several factors to consider when minimizing the impact on biodiversity, and it was not possible to include all those factors in this study. Some others to consider are water quality, water use/scarcity, and other groups relevant to biodiversity, such as aquatic species. Further study of alternative interventions could provide information on additional ways to increase biodiversity in an area, such as avoiding monocultures through crop rotation and diversification or restoring riparian areas.

EII

Impacts

The EII metric score ranges from 0 to 1, with scores from 0.8 – 1 indicating a healthy, natural ecosystem. Within cotton production landscapes, the national mean EII score was 0.472 (Figure 4). Cotton production areas across the country have relatively similar EII values with most ranging between 0.35 – 0.6 (Figure 5). The lower scores could indicate one of two things; slightly less ecosystem integrity due to cotton's ability to grow in low integrity ecosystems, or that cotton has contributed to lower integrity in the ecosystem.

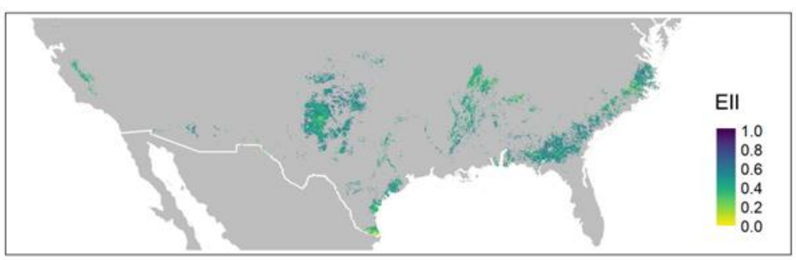

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Figure 4. *EII of cotton fields in the USA. The map shows baseline EII for all cotton fields in the USA.*

[7] https://doi.org/10.1007/s13165-020-00279-2

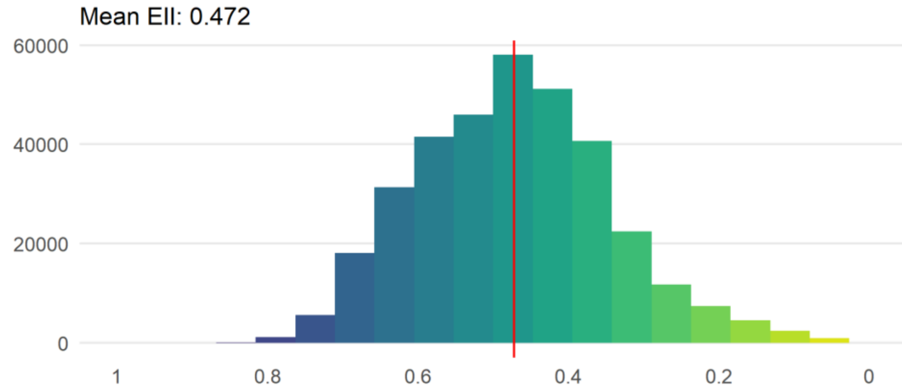

Figure 5. *The histogram shows the spread of baseline EII values in the area, with a red vertical line indicating mean EII.*

Interventions

We used EII to assess the potential ecosystem impacts on cotton production regions in the United States if companies were to convert from traditional farming practices to organic practices. This shift to organic practices for all cotton production in the country could result in an increase in mean EII of 0.062 or approximately 13%, from the baseline score of 0.472 to the intervention score of 0.534 (Figure 6a and 6b). This means that ecosystem integrity would go up with transition to organic practices.

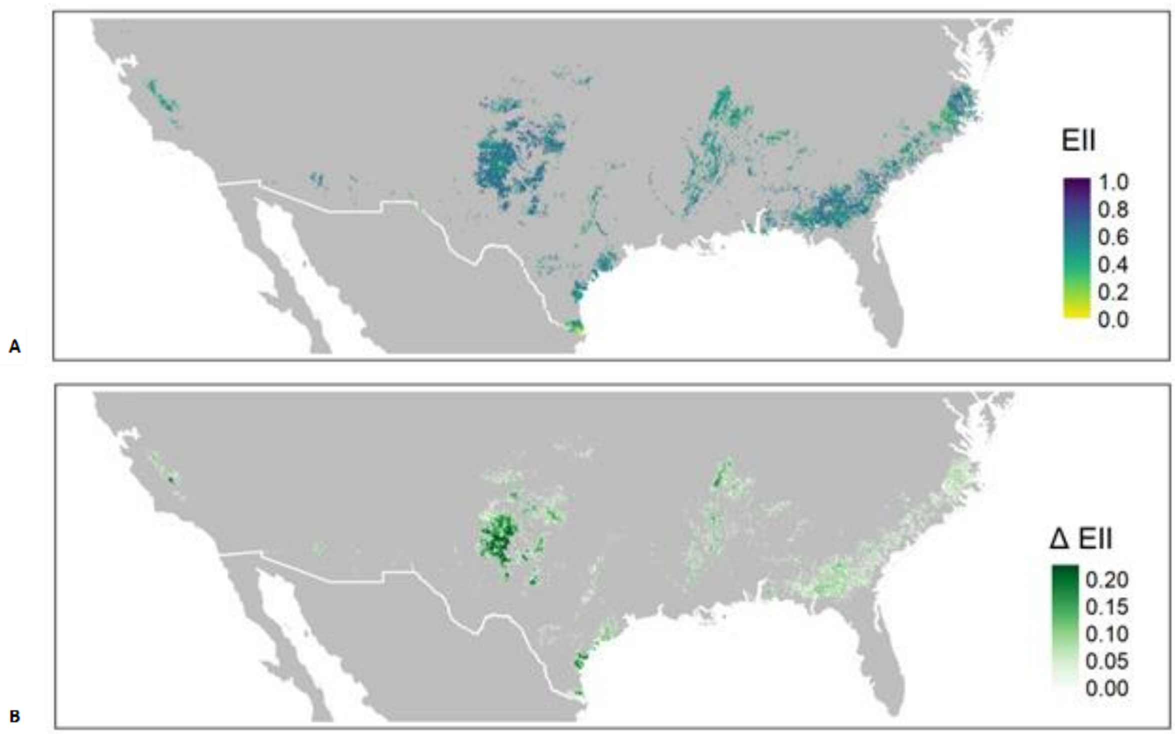

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Figure 6A and 6B. *Maps illustrating the impact on EII of implementing organic practices in all cotton fields in the USA. (A) The first map shows EII resulting from the intervention of a shift to organic farming practices across all cotton fields in the USA. 0-1 being a scale of naturalness (integrity). (B) The second shows change in EII between the baseline and intervention.*

Notably, a displacement to the left in the histogram of EII values shows that an EII value of ~0.6 is found for the highest number of pixels (Figure 7). Converting to organic farming practices would positively impact all cotton across the country with variation impact based on the locality. These score increases can range from 0.1 to over 0.2. The projected areas to experience the highest increases in ecosystem integrity would be in the central USA geographies of the country, which coincides with the largest concentration of cotton fields and thus would benefit ecosystem integrity directly.

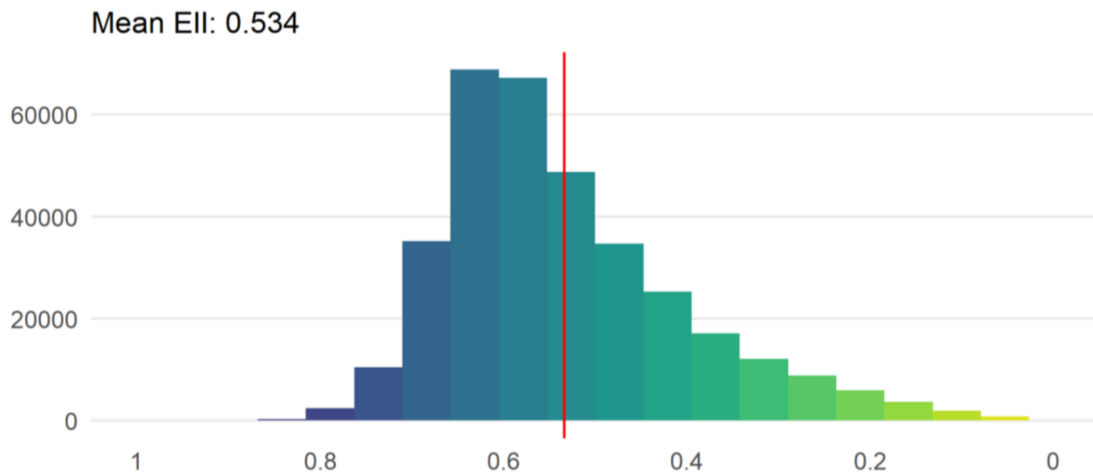

Figure 7. *Histogram showing the spread of EII values with a shift to organic farming practices for all cotton fields in the USA. The red line shows the mean EII.*

The second intervention was the protection of riparian areas. Findings show that by implementing a natural 50-meter buffer zone alongside all rivers within the USA cotton producing areas this would cause an increase in the mean EII from 0.472 to 0.476, a 0.004 or 0.84% increase. These results indicate protection of riparian area would only be impactful where there is a high concentration of rivers or in a more local context compared to across the entire country where there are large regions with no rivers and therefore no change in the ecosystem integrity for this intervention.

Land Hub Indicators

Impacts

The SBTN Land Hub Impact Indicators are calculated on a per-hectare basis to examine the land impacts in the cotton producing regions. The factors included: amount of soil erosion, loss of soil organic carbon (Figure 8), reduction in vegetation loss (forest) (Figure 9), and terrestrial eutrophication (Figure 10).

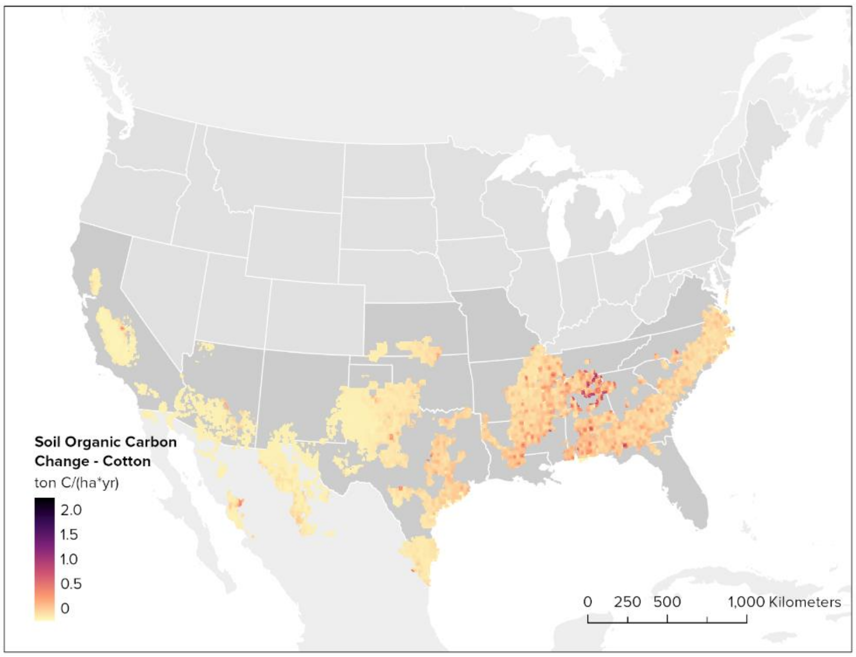

Figure 8. *Land Hub Indicators for the change in soil organic carbon. The darker areas show a greater change in soil organic carbon, with higher change though the south/southeast USA.*

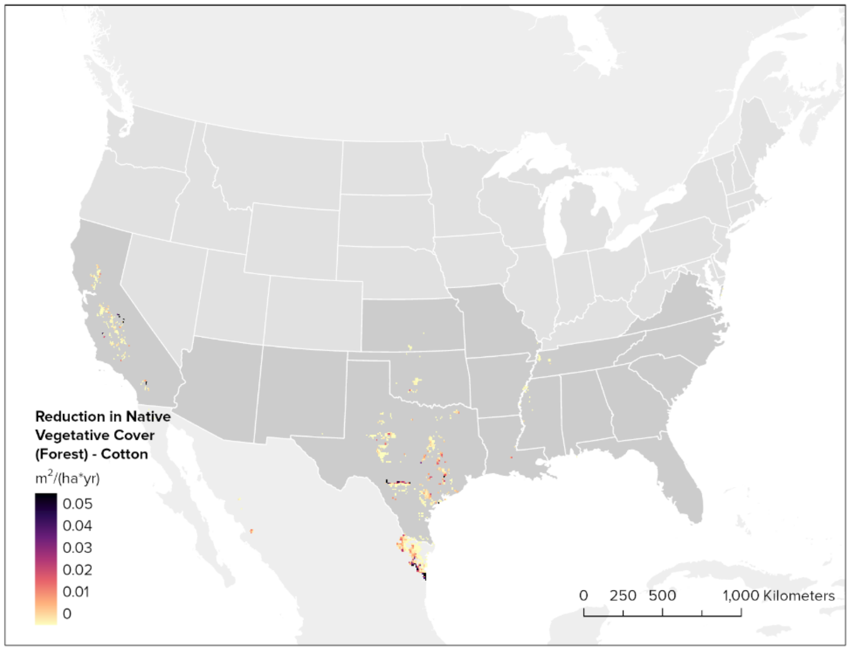

Figure 9. *Land Hub Indicators for the reduction of native vegetation cover. At the country level, the loss is not significant, likely because the land suitable for cotton production is not typically in areas with forest cover.*

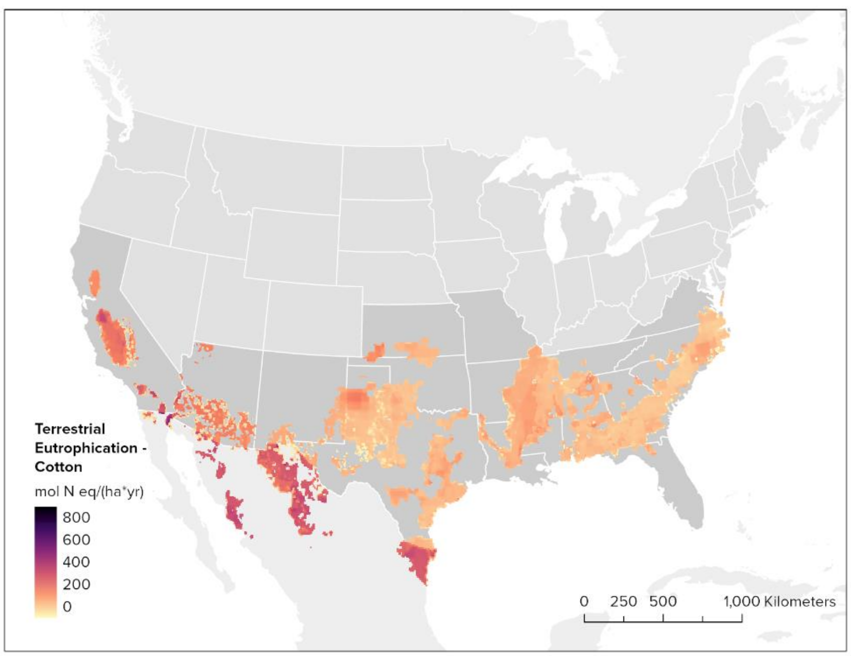

Figure 10. *Land Hub Indicators for amount of terrestrial eutrophication. The darker areas indicate a greater amount of Nitrogen equivalent, with higher terrestrial eutrophication in the southwestern parts of the USA.*

CONCLUSION AND NEXT STEPS

This deep-dive analysis gives a high-level overview of cotton production impacts on nature and biodiversity in the United States. Using country-level data allows us to see areas that are more affected by production and should be considered a higher priority because of the biodiversity present or because of its susceptibility to ecosystem degradation. Companies with granular data or supply chain traceability, such as georeferenced supplier locations, can view detailed current and future biodiversity and land impacts. If companies are sourcing within the United States, the US bailing system is an easy way to trace the supply chain and could help provide more localized data. Better supply chain data ultimately results in better findings and more credible goals, commitments, and recommendations that are targeted to the highest priority areas for biodiversity and land.

As demonstrated in this study, cotton grown in the United States – even organic cotton – is not free of impacts on nature. There are key species threatened by the production of cotton in the USA, ecosystems that would positively benefit from organic farming practices and ecosystem protection, and land-based factors that are affected by production. A key takeaway from shifting to organic practices is if the production footprint increases due to the transition resulting in lower yields, the benefits supplied by organic practices are negated when more land is required. For organic practices to be beneficial, yield and production footprint likely need to remain constant with previous practices to avoid negative biodiversity impacts. To assess these subsequent impacts, further analysis should be considered, especially on the ground assessments, given the limitations of the metrics to measure all organic practice actions.

As a company considers its commitments to nature and interventions in its cotton supply chain, it will be important to align with recognized best practices, such as SBTN. This will ensure not only the credibility and ambition of commitments, but also allows the whole sector to work towards common targets and streamlining engagement with producers and suppliers on traceability data needs. As SBTN launches their version 1.0, we recommend reviewing the guidance and recommended metrics and indicators, and to apply a Science-Based Targets process to any nature and biodiversity commitments in the future.

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