IBAT

June 2021

Species Threat Abatement and Restoration (STAR) data layer

Business User Guidance

STAR · Powered by IUCN RED LIST

Sumatran Orangutan
Pongo abelii
Critically Endangered

IBAT alliance partners

BirdLife INTERNATIONAL · CONSERVATION INTERNATIONAL · IUCN · UN environment programme · WCMC

Report prepared by

THE BIODIVERSITY CONSULTANCY

Table of Contents

Saiga
Saiga tatarica
Critically Endangered

1 Who is this guidance for?

This guidance provides an overview of the Species Threat Abatement and Restoration (STAR) data layer and its application. It aims to support businesses and help them apply the STAR layer to identify opportunities for investment into species conservation to support science-based targets for nature. This manual is aimed at impact investors, developers, private sector financers and practitioners working with the private sector.

The data underpinning STAR, and the metric's range of potential applications, are developing rapidly. Guidance updates and new examples will be posted on IUCN's conservation tools web page.

2 Context

STAR allows quantification of the potential contributions that species threat abatement and restoration activities offer towards reducing extinction risk. STAR provides a metric that can be used by businesses to support establishment and reporting of science-based targets for nature, and commitments relevant to the post-2020 biodiversity framework. It allows businesses to assess and compare the potential gains from particular nature-positive actions in specific locations.

2.1 How is STAR different from the Red List Index?

The Red List Index (RLI) is a well-established and widely-used metric that is also based on the IUCN Red List. It tracks changes in the threat status of species, showing if collective extinction risk is increasing or decreasing. However, the RLI is not well suited to most business applications as it works best at large scales, is not very responsive to change, and is not additive or scaleable. In contrast, STAR is fully scalable and provides a quantitative score that can be broken down by threat type to help identify and prioritise conservation action.

Key features of STAR include:

- STAR is a biodiversity metric, based on The IUCN Red List of Threatened Species, that allows businesses to measure their impacts against science-based targets for nature (Section 3);

- STAR focuses on species extinction risk, using information on where threatened and near-threatened species occur (or used to occur) and on the threats they face (Section 3);

- Threatened species are of high concern to stakeholders and regulators, and a focus for global biodiversity goals. STAR's focus on threats has several practical advantages (Section 4);

- Businesses can use STAR for a range of applications in biodiversity management, for assessing opportunities to reduce species extinction risk and helping understand potential positive and negative impacts associated with operations on the ground (Section 5);

- STAR scores are calculated based on the proportions of threatened species' ranges present at a location, weighted by their extinction risk. Scores can be used to compare and identify species threat abatement and restoration opportunities across multiple areas of interest (Section 6);

- STAR is a standardised and versatile metric that can be assessed at different scales and added, partitioned and compared across different geographies and types of threat. It allows users to assess the potential contribution of species threat reduction actions in any given Area of Interest towards global goals for extinction risk reduction (Section 7);

- As a species metric, STAR complements metrics based on ecosystem extent and condition. STAR information can also be used to add a biodiversity significance component to ecosystem metrics (Section 8);

- The metric currently covers amphibians, birds and mammals. These taxon groups are fully assessed in the IUCN Red List and thus allow global application of STAR. Additional taxonomic groups including freshwater and marine species can be added to the layer in future (Section 9).

3

I'iwi
Drepanis coccinea
Vulnerable

3 What is the STAR layer?

STAR uses existing species and threat data from the IUCN Red List to produce two complementary global layers presenting threat abatement and restoration potential (Figure 1). This enables identification of specific threat abatement and habitat restoration opportunities to reduce species extinction risk. STAR scores for any given Area of Interest therefore provide an indication of the relative potential contribution to reducing species extinction risk through either threat abatement or restoration activities.

STAR scores are derived based on a species' current and restorable Area of Habitat (AOH). Scores are currently calculated for species of amphibians, birds and mammals for which current or historical AOH are available. Additional taxon groups are expected to be included over time. Additional limitations of STAR are presented in Section 9.

Further information on the development of the STAR layer can be found in the publication by Mair et al., 2021.[1]

3.1 Threat abatement STAR (STAR$_T$)

For a defined Area of Interest, STAR$_T$ represents the summed scores of the proportion of each species' habitat range present, weighted by the species' IUCN Red List status. Scores indicate the potential contribution towards reduction of global species extinction risk from threat abatement actions in the Area of Interest. The sum of STAR$_T$ values across all species represents the global threat abatement effort needed for all species to become Least Concern. High scores indicate areas that currently contain relatively many threatened species, a large proportion of individual species' ranges, and/or species that are severely threatened.

The STAR$_T$ score can be broken down to show the relative contributions of different threats.

This enables identification of actions to abate specific threats to contribute to species conservation goals. These may include, for example, actions to modify production techniques to be compatible with species survival, or to control hunting, pollution or invasive species.

Section 6 provides further details on how STAR$_T$ scores are derived.

3.2 Restoration STAR (STAR$_R$)

STAR$_R$ uses a similar approach to STAR$_T$, but for areas that previously supported species that are no longer present. High scores indicate areas that previously supported relatively high numbers of threatened species, a large proportion of individual species' ranges, and/or species that are severely threatened. The STAR$_R$ score therefore shows the potential contribution towards reduction of global species extinction risk through restoration actions in a given Area of Interest. Such actions may involve habitat restoration and/or removal of stressors such as hunting that are preventing species' recolonisation. For a defined Area of Interest, STAR$_R$ represents the summed scores of each species' restorable range, as a proportion of the current range, weighted according to each species' IUCN Red List status. These scores can also be broken down to show the relative contributions of different threats that may need to be addressed, alongside habitat restoration, in the restorable area.

A discounting multiplier is applied to STAR$_R$ scores to reflect the fact that species restoration is generally slow and may not be fully successful. Again, STAR$_R$ scores can be disaggregated by threat, and summed across species within the location.

Section 6 provides further details on how STAR$_R$ scores are derived.

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1   Mair, L., Bennun, L.A., Brooks, T.M., Butchart, S.H.M., … Hawkins, F. & McGowan, P.J.K. (2021) **A metric for spatially explicit contributions to science-based species targets**. Nature Ecology & Evolution 1–8.
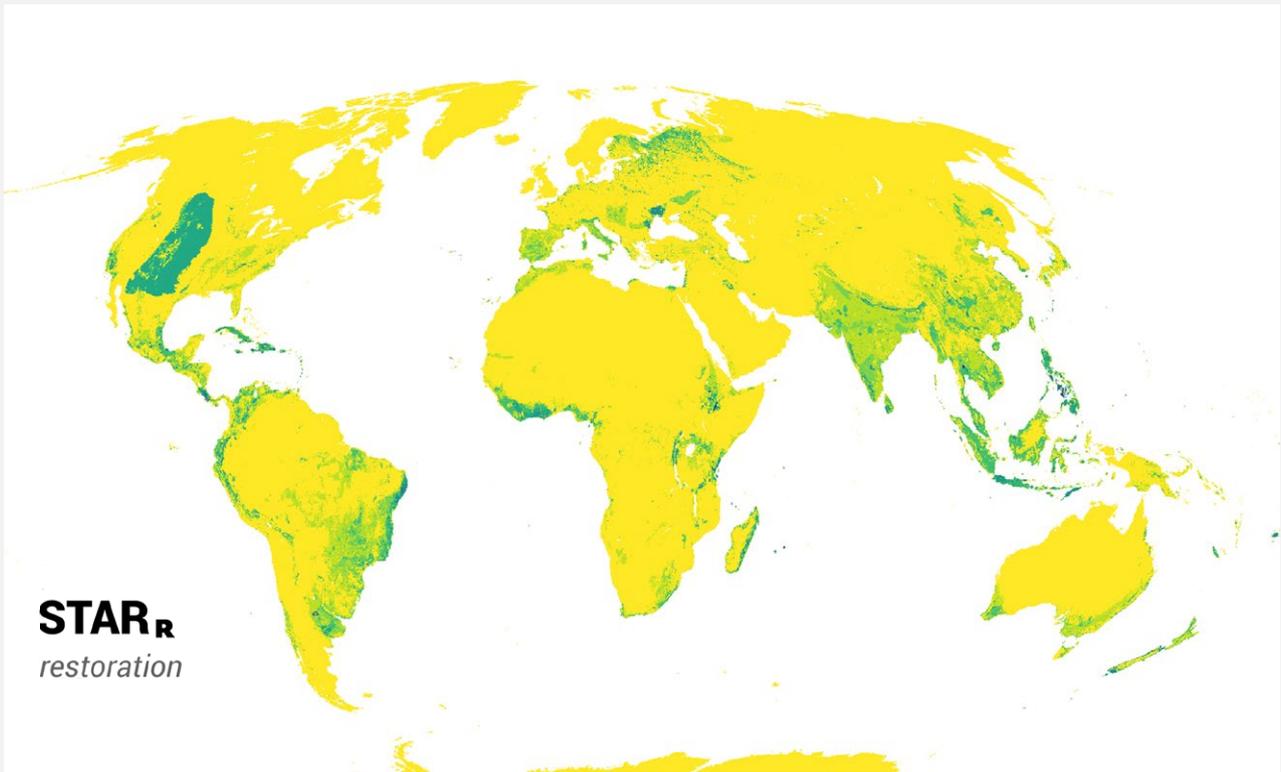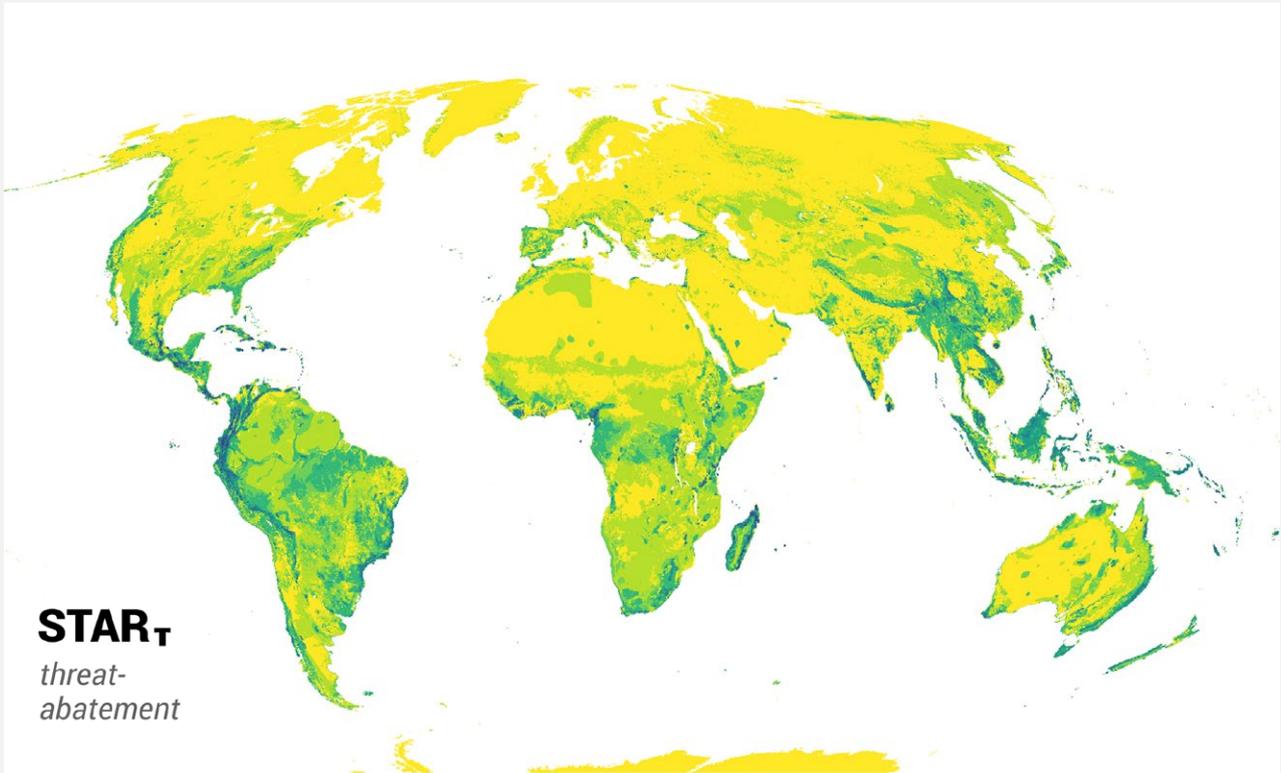
Figure 1: *Global STAR scores for (top) STAR$_T$ threat-abatement and, (bottom) STAR$_R$ restoration. Quantitative STAR scores are placed into categories from Very Low to Very High. The Very Low category includes scores at or near zero, shown in yellow. Note that threatened species and important biodiversity can still be present in areas with very low STAR scores. Grid cells are at a 5-km resolution.*

4 How can STAR benefit your business?

STAR offers businesses an approach that is robust, scientifically-based and easy to use (see Section 7 for how to access STAR). STAR can be used to assess biodiversity-related opportunity and risk at multiple scales, from corporate-level screening to project-level assessment. It builds on, and complements, related and underpinning data (e.g. Key Biodiversity Areas (KBAs) and the IUCN Red List), but factors in species extinction risk and individual threats. This is particularly relevant for areas that have not been assessed, outside of identified KBAs.

STAR is completely scaleable and can be disaggregated by threats, allowing comparison between sites. As such, STAR can be used to help identify potential impacts across a corporate's supply chain (to the threatened and near-threatened species included in STAR), undertake a portfolio assessment of biodiversity opportunity and risk[2], and help prioritise investments into species conservation.

In turn, STAR can enable companies to set and measure progress on species-focused "science-based targets" for nature, and contribute towards wider national or international goals, such as those due to be developed under the post-2020 Global Biodiversity Framework and the Sustainable Development Goals.

As a single, standardised global layer available via the Integrated Biodiversity Assessment Tool (IBAT), STAR can be applied to any user-defined Area of Interest without the need for site-specific data. Where more detailed data on species status or threats are available they can be used to validate and improve accuracy of STAR outputs.

African Wild Dog
Lycaon pictus
Endangered

STAR has a wide range of potential business applications, some of which include:

Screening

- **Screening for opportunities to invest in the most impactful conservation actions.** STAR can map and quantify where conservation investments and actions can most reduce species' extinction risk, either by abating threats to species or through restoration activities.

- **Screening for conservation risks associated with business operations.** In combination with other biodiversity data layers[3], STAR can also help screen (and provide a quantitative element) for biodiversity risk. Screening can be applied across multiple scales, from a specific project site through to a landscape, to multi-commodity production base or a whole sector (e.g., mining, agriculture or fashion). Screening can help assess against financial safeguards (e.g. to support identification of IFC Performance Standard 6 Critical Habitat, based on species AOH).

Planning

- **Target setting.** STAR can readily be used to set science-based biodiversity targets focused on species extinction risk, for a particular site, portfolio, country or corporate. The STAR score within an Area of Interest represents the potential contribution that a business or investor could make towards reducing species extinction risk.

- **Mitigation planning.** STAR can be used to prioritise mitigation effort or to address key threats to species. STAR scores can be broken down by threat type, to help identify targeted actions to abate threats and reduce the extinction risk of species. At the project level, STAR can inform early project planning (alongside other information), to help identify and avoid areas of high biodiversity sensitivity.

- **Offset planning** STAR can also help developers identify suitable areas for biodiversity offsets, through actions that avert future losses and/or restore lost or degraded habitat. Note that site-level planning will require site-specific validation of species and threats to provide a reliable basis for planning.

Tracking

- Future development of the STAR metric will allow it to be used to track progress towards conservation goals, inform adaptive management and report results to stakeholders.

Limitations of STAR application, and how these need to be accounted for, are explained in Section 9.

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2   Assessment of risk should be undertaken in combination with additional biodiversity datasets to develop a more complete picture of the biodiversity significance of the area.

3   Including the Critical Habitat layer and information on Key Biodiversity Areas, Protected Areas and IUCN Red List of Species available through IBAT.

5 STAR typology

STAR has a range of current and potential uses. Three broad categories of STAR outputs can be defined (Table 1):

Table 1

Summary of STAR typologies and potential application

STAR typology	Uses	Description	Example of application	Current potential and limitations of use
Potential STAR (estimated): The STAR score derived from an Area of Interest using the global STAR layer for threat abatement ($STAR_T$) and/or restoration ($STAR_R$).	**Screening and corporate-level planning** Used to identify potential opportunities to abate threats and undertake species restoration activities to reduce their extinction risk. Allows a business to establish appropriate targets for reducing species extinction risk through either threat abatement or restoration activities in a range of contexts: • Industry contributions to national or global biodiversity goals. • Setting voluntary science-based targets for nature. • Scaling requirements for corporate 'nature positive' commitments.	**Threat abatement ($STAR_T$)** Spatial assessment of relative opportunity for conservation gains through threat abatement activities. STAR threat abatement scores can be broken down by type of threat to identify and prioritise actions to abate specific threats. **Restoration ($STAR_R$)** Spatial assessment of relative opportunity for conservation gains through species restoration activities.	Commodity company looking to identify opportunities to invest into species conservation actions within the landscape it is impacting through its supply chain (see Section 7 for a worked example).	• IBAT does not yet provide STAR scores for individual species. STAR is currently calculated for terrestrial species and does not yet include assessment of marine or freshwater biomes. • Can provide quantified information on biodiversity risk but additional information is required to understand the full biodiversity significance of an Area of Interest, particularly ecosystem extent and health. • Potential STAR (estimated) is based on global data layers. Site-specific information is needed for detailed planning and more accurate assessment of potential positive/negative impacts (see Potential STAR (calibrated)).
Potential STAR (calibrated): Ground-truthed, validated, version of Potential STAR (estimated) that applies site-specific data on species status and/or threats. Provides a more accurate picture for the Area of Interest.	**Screening and project-level planning** A locally calibrated version of STAR that can be used to assess realistic potential STAR gains from conservation interventions for species threat abatement and/or restoration. Can also be used to inform offset pre-feasibility by assessing potential for achieving gains through either averted-loss or restoration type offsets.	A 'ground-truthed' version of the Potential STAR (for both threat abatement and/or restoration) that provides a more accurate picture of the potential gains from conservation or restoration interventions at a particular site, based on site-specific information. The Potential STAR scores are adjusted according to site-specific information about: (a) the proportion of species' population and the non-negligible threats actually present at the site, and/or (b) the potential and feasibility of species restoration activities, and any threats that restoration cannot fully address (for which the potential STAR score should be discounted).	A large-scale mining project looking to understand its potential species impacts and identify suitable sites for undertaking offsets within the landscape.	• Requires further testing to understand applicability and constraints. • Requires detailed information on species distribution (% of global population) and threats (i.e., presence and relative significance) within the Area of Interest. • If comparing sites within a country or region, can include distribution and threat scoring data for other IUCN Red List assessed taxa, and/or for nationally threatened species. • Site-specific data and detailed threat mapping may be used to update the global STAR layer in future.
Realised STAR: The STAR score representing the realised conservation losses or gains (sometimes referred to as "ex post" STAR).	**Tracking** Allows corporate tracking and reporting of progress towards corporate science-based targets for nature and contributions to wider conservation goals.	Helps a business monitor their contribution to STAR (for both threat abatement and/or restoration), at one or more projects and/or through conservation investments, by measuring changes in threat intensity and the corresponding change in STAR score. Can be used to measure positive impacts (e.g. decreased species extinction risk due to corporate interventions to abate species threats and/or undertake species restoration) but also negative impacts (e.g. increased species extinction risk due to a project's footprint).	A commodity company tracking its contribution to reducing species' threat intensity against a national target (see Section 7 for a worked example).	• Requires further testing to understand applicability and constraints, including the use of counterfactuals against which to assess change in threat intensity. • May require additional information to understand full biodiversity significance of an Area of Interest, particularly ecosystem extent and health.

6 How are STAR scores calculated?

STAR scores for any Area of Interest are calculated by summing the proportion of each species' extent of current and restorable Area of Habitat (AOH) that is within the area, as a percentage, weighted by their extinction risk. STAR scores are generated in IBAT and presented within the user-generated report (see Section 7 for further details).

For each 5-km square, the **STAR Threat Abatement score (STAR$_T$)** for a species is assessed based on the proportion of current range represented by the grid square, and the species' extinction risk (Figure 2). The total, global STAR$_T$ score for an individual species varies from zero for Least Concern species to 400 for Critically Endangered species (Table 2). The sum of STAR$_T$ values across all species represents the global threat-abatement effort needed for all species to become Least Concern. STAR assumes that complete alleviation of current threats would reduce extinction risk to Least Concern status, either by preventing further decline or allowing recovery of a species' population and distribution (Mair et al., 2021). Adding STAR scores across all species gives the total STAR score for the square. STAR Threat Abatement scores indicate a location's relative potential contribution to reducing species' extinction risk, one measure of biodiversity significance. Scores can also be broken down to show the relative opportunity to abate the different threats[5] causing species to be at risk of extinction.

STAR Restoration scores (STAR$_R$) are calculated similarly to STAR Threat Abatement Scores, but for areas formerly occupied by a species. For each species, scores are calculated according to the species' former range ('restorable habitat') present in the cell as a proportion of the species' current range, weighted by its IUCN Red List status. Restorable habitat is based on the extent of original ecosystem types before they were converted by humans to croplands, pasturelands or urban areas. STAR scores indicate the potential of restoration within a grid cell to reduce species' extinction risk. A global weighting of 0.29 is applied to STAR$_R$ scores based on studies of restoration success[6], to discount for the time taken for restoration and its probability of succeeding. STAR$_R$ scores can also be disaggregated by threat, based on the threats acting within the species' current range.
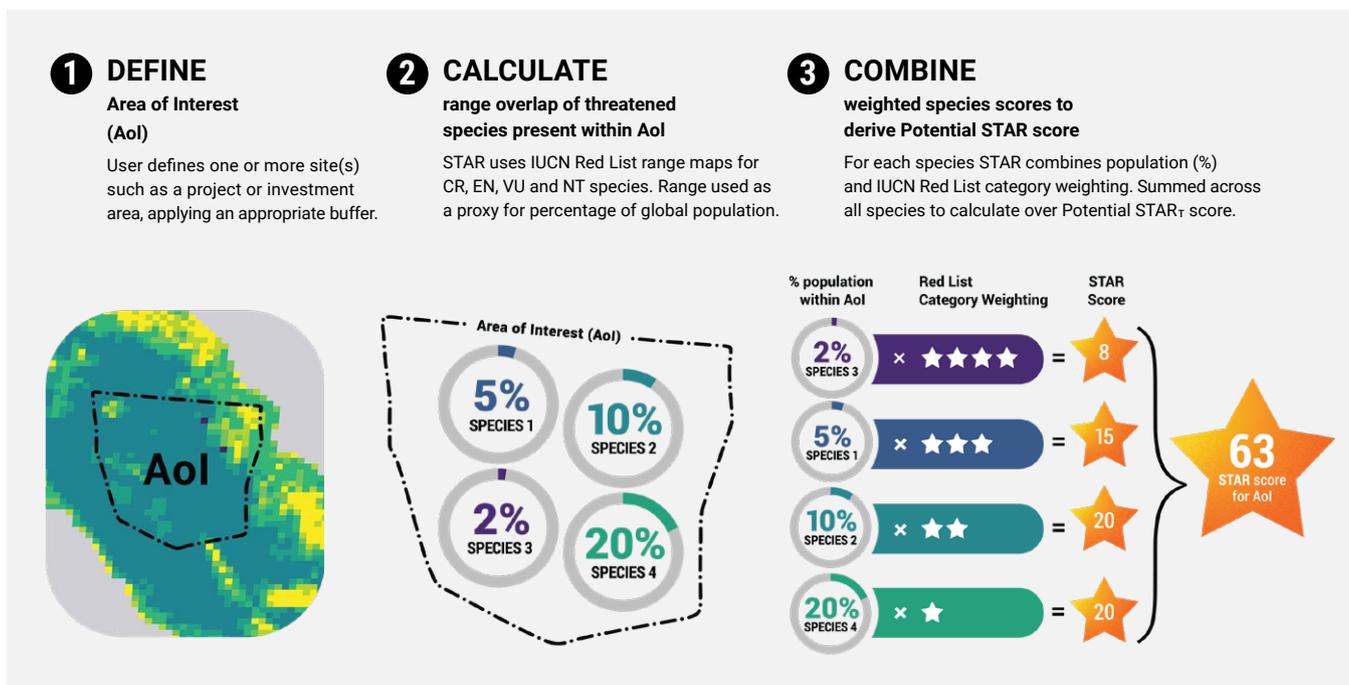
Table 2

STAR weighting based on a species' IUCN Red List threat status

Species IUCN Red List status	Status score weighing	Maximum species score[4]
CR Critically Endangered	★★★★	400
EN Endangered	★★★	300
VU Vulnerable	★★	200
NT Near Threatened	★	100

1 DEFINE

Area of Interest (AoI)

User defines one or more site(s) such as a project or investment area, applying an appropriate buffer.

2 CALCULATE

range overlap of threatened species present within AoI

STAR uses IUCN Red List range maps for CR, EN, VU and NT species. Range used as a proxy for percentage of global population.

3 COMBINE

weighted species scores to derive Potential STAR score

For each species STAR combines population (%) and IUCN Red List category weighting. Summed across all species to calculate over Potential STAR$_T$ score.

Figure 2: Process for deriving Potential STAR$_T$ scores from the global STAR layer. A detailed example of is provided in Section 7.

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4   Achieved where entire species AOH is found within the Area of Interest.
5   Threats are defined according to the IUCN Red List Threat Classification Scheme.
6   See Mair et al. 2021: based on the median rate of recovery from a global meta-analysis by Jones, H. P. et al. Restoration and repair of Earth's damaged ecosystems. Proceedings of the Royal Society B: Biological Sciences **285**, 20172577 (2018).

6.1 STAR threat types

STAR$_T$ scores can be disaggregated by threat, to show the relative contribution of different threat types to the overall STAR score. This allows for identification of actions to abate specific threats at one or more AoIs, and quantification of their contribution to the global abatement of extinction risk for all species present in the AoI (Table 3). For further information on the threat types used in STAR, see Appendix 2.

6.2 Data underpinning STAR scores

Datasets used to produce the STAR layer and values are:

- IUCN. The IUCN Red List of Threatened Species. Version 2019-3. (2019). https://www.iucnredlist.org

- IUCN. Threats Classification Scheme. Version 3.2. (2019).

- Strassburg, B.B.N., Iribarrem, A., Beyer, H.L. et al. Global priority areas for ecosystem restoration. Nature 586, 724–729 (2020). https://doi.org/10.1038/s41586-020-2784-9

Table 3
Example of STAR scores for an AoI disaggregated by threat types.
Threat types are also presented based on their relative contribution to the total STAR score (as a %).

Species	IUCN Red List category	IUCN Red List category weight	Population in AoI (%)	Invasive species	Energy & mining	Biol Res Use	Agriculture	Climate change	Pollution	Potential STAR$_T$
1	EN	3 ★★★	5%	0	0	2	9	4	0	15
2	VU	2 ★★	10%	8	9	0	0	3	0	20
3	CR	4 ★★★★	2%	0	0	4	3	0	1	8
4	NT	1 ★	7%	0	0	3	4	0	0	7
	Total Potential STAR$_T$ (% of total STAR score for AoI)			8 (16%)	9 (18%)	9 (18%)	16 (32%)	7 (14%)	1 (2%)	50 STAR score for AoI
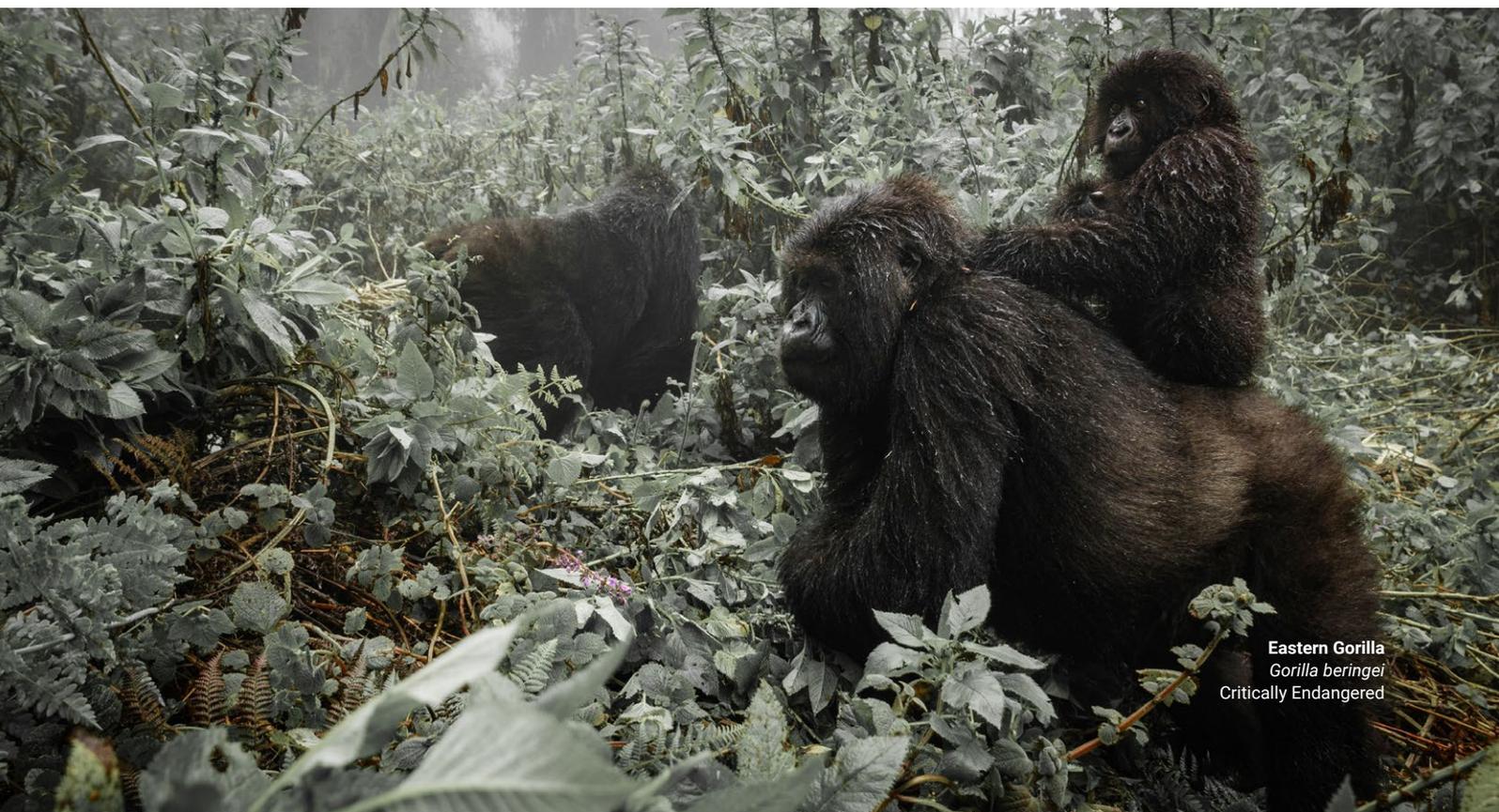
Eastern Gorilla
Gorilla beringei
Critically Endangered

7 How to use STAR

The global STAR$_T$ and STAR$_R$ maps are available through the Integrated Biodiversity Assessment Tool (see Box 1). IBAT users are able to generate IBAT STAR Reports to determine site-specific scores. For a defined Area of Interest, the report provides a detailed breakdown of the STAR values, threats and their relative significance at national and global scales (see Appendix 1 for an example report).

To facilitate ease of use and mapping of relative STAR values in IBAT, both STAR$_T$ and STAR$_R$ scores are presented in categories from "Very Low" to "Very High" (Table 4). Even in "Very Low" grid cells there may still be important biodiversity present, and it should not be assumed that these areas have no biodiversity significance.

To ensure that STAR scores reflect the wider ecological context of the landscape (and not just a single site), it is recommended to apply a sufficiently large buffer (e.g. 50 km) around the perimeter of an Area of Interest. This also facilitates identification of additional conservation options within the wider landscape.

To provide a more comprehensive and accurate picture of the biodiversity significance of an area, STAR should be combined with other biodiversity metrics, particularly those that account for ecosystem condition (see Section 8). It is recommended to work with biodiversity specialists to help interpret the findings and ensure they are considered within the wider ecology and conservation significance of the area.
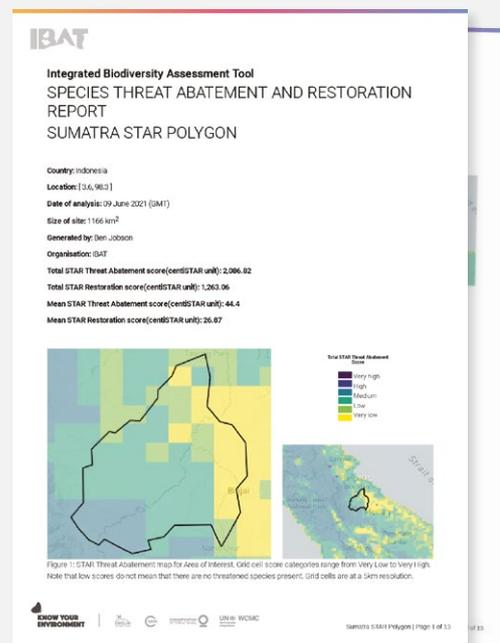
Table 4

Designation of STAR scores into categories for mapping outputs

COLOR CODE					
STAR CATEGORY	VERY LOW	VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
STAR score range (5×5 km grid square)	0–<0.01	0.01–<0.1	0.1–<0.1	1–<10	10–<100	100–1000

Integrated Biodiversity Assessment Tool
SPECIES THREAT ABATEMENT AND RESTORATION REPORT
SUMATRA STAR POLYGON

7.1 STAR user case example: investing into species conservation actions to achieve positive outcomes for nature

In this example, a large consumer goods company sourcing soy from South-East Asia is looking to compensate for its supply chain-impacts and contribute towards global and national conservation goals (Figure 3). The step-by-step process of extracting STAR data from the global layer to inform opportunity assessment using Potential STAR (estimated) is presented below:

1. To address its impacts and achieve positive species conservation outcomes, the company will need to achieve a STAR score of ten (10), equating to 2% of the national target of 20% of its total STAR of 2,500 by 2030. 20% (STAR score of 500) represents the country's national contribution to align with global goals for improving the status of threatened species.

2. To meet both its national and its own nature positive commitments, the company is looking to invest into both threat abatement and restoration activities within the landscape.

3. Using the global Potential STAR (estimated) layer, three potential sites (AoIs) are identified for further consideration (see Figure 4).

4. A query to IBAT for these sites provides three STAR user reports (see Appendix 1 for a sample report).

5. $STAR_T$ and $STAR_R$ values for the three sites are compared against each other (Table 5).

6. Site C is chosen for further assessment as STAR indicates it can provide a potential STAR of 20 units (Table 5):

   - Actions aimed at abating current threats can achieve a Potential $STAR_T$ score of **14**.

   - Actions aimed at restoring degraded forests can achieve a Potential $STAR_R$ score of **6**.

7. The company recognises it can only achieve a proportion of the Potential STAR score, as it will not be able to completely arrest current species losses, or fully restore degraded forests within the intended timeframe. It engages conservation NGOs already working in the landscape to understand what conservation actions it can support. It then develops a detailed action plan with specific species conservation targets, to identify what STAR target can realistically be achieved. It identifies two approaches that, if successful, will deliver a Realised STAR contribution of 10 (2% of national target):

   - Reducing conversion of forest for cattle ranching and addressing the threat of invasive species can achieve a $STAR_T$ score of **eight** across the landscape **(1.6% contribution to national target)** (Table 6);

   - Actions aimed at forest restoration can help expand species AOH in the same AoI, further contributing to $STAR_R$ target by **two** units **(0.4% contribution to national target)**.

Company establishes STAR target, aligned with national species conservation goals

National STAR target
20% of national STAR score of 2500 by 2030
500

Company STAR target
Contribute 2% of national STAR target
10

Company identifies potential sites to undertake species threat abatement and restoration actions

Company's POTENTIAL STAR target
Theoretical maximum
4% of national STAR target
20

Company works with stakeholders to identify and develop specific species conservation actions and achieve its STAR target

Company's REALISED STAR target
Realistically achievable
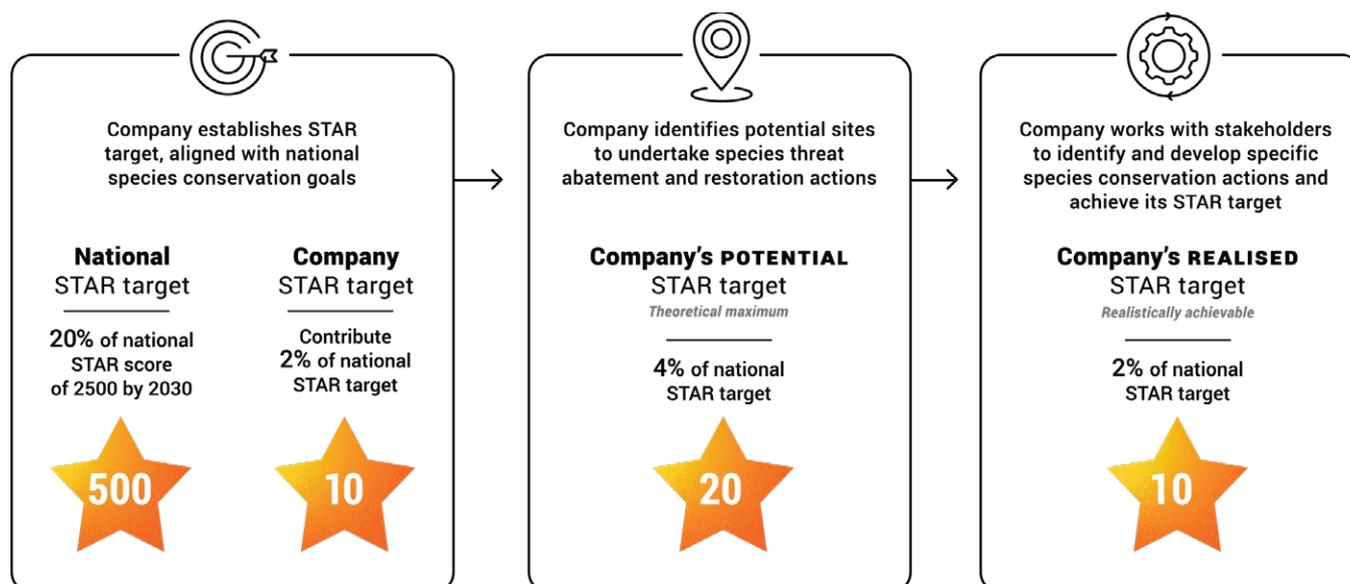2% of national STAR target
10

Figure 3: Approach to establishing a STAR target and identifying species threat abatement and restoration actions to achieve the target.

The company works with NGOs to establish a monitoring and review protocol. This will allow it to measure the STAR contributions that can be attributed to its conservation interventions and help ensure the project stays on track to meet the species conservation targets. To do this, it monitors the rate of change at both the intervention sites and a number of proxy sites elsewhere in the same landscape. This allows it to understand the impact of its interventions against background changes happening within the wider landscape. See Section 7.2 for further information.

7.2 Measuring STAR contributions against background change

To understand STAR gains that can be attributed to specific conservation actions, it is important to determine what the pressure intensity would have been in the absence of the intervening actions. Some assumptions will need to be made and a rationale provided to justify trends in pressure at the site before the intervention, as well as trends in pressure elsewhere after the intervention, using one or more control areas.

The gain from reducing pressure is the proportional reduction achieved in the 'counterfactual' pressure intensity (i.e. the level predicted in the absence of intervention). This aspect of applying STAR is in technical development and will be presented more fully in future guidance.
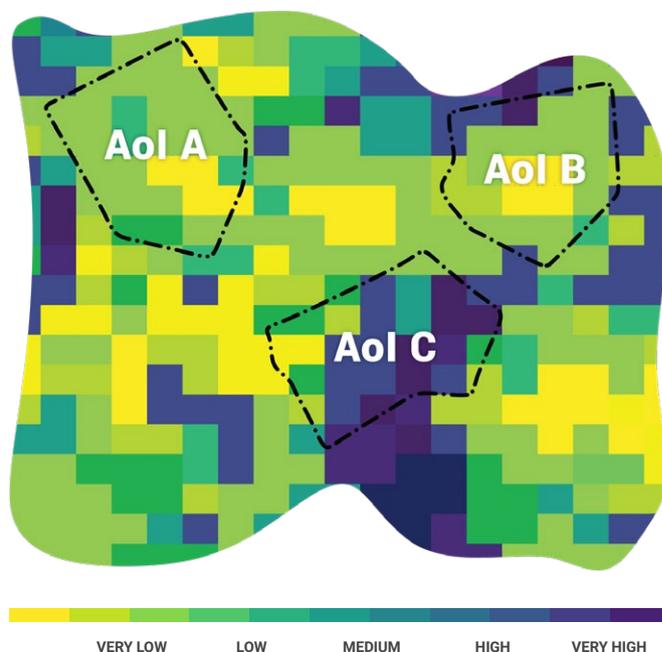

| VERY LOW | LOW | MEDIUM | HIGH | VERY HIGH |

Figure 4: *Potential sites (AoIs) in the landscape for undertaken threat abatement activities, based on the Potential $STAR_T$ (estimate) layer.*

Table 5
Comparison of Potential $STAR_T$ and $STAR_R$ values for the three AoIs

AoI	Potential $STAR_T$	Potential $STAR_R$	Total	% of country score
A	6	6	**12**	0.48%
B	7	8	**15**	0.6%
C	14	6	**20**	0.8%

Table 6
Potential and maximum Realised $STAR_T$ scores for AoI C

Threat type	Total Potential $STAR_T$ across Area of Interest	Total Realised $STAR_T$* across Area of Interest
Farming/ranching	8	5
Climate change	1	0
Invasive species	4	3
Other	1	0
Total	**14**	**8**

* i.e., the maximum STAR score that can realistically be achieved through species conservation actions

Indian Pangolin
Manis crassicaudata
Endangered

8 Additional approaches that can support STAR

STAR data is based on the IUCN Red List to provide an indication of risks and opportunities to species. It can be supplemented with additional biodiversity metrics and datasets to provide a more comprehensive picture of the state of biodiversity within a particular area. For example, the upcoming Green Status of Species, which assesses progress towards species recovery and ecological functionality, can bring in additional non-threatened species not covered by STAR.

STAR can provide the significance component of a Biodiversity Extent Condition and Significance (BECS) measure. Datasets helpful for assessing ecosystem extent and condition include:

- The IUCN Terrestrial habitat types layer

- The Natural and Modified Habitat layer

- The Global Ecoregion Intactness layer

- The Forest Structural Integrity layer

STAR can also be integrated within supply chain assessments to measure and track biodiversity and threats, for example, through the Biodiversity Risk in Supply Chains (BRISC) framework.

Kagu
Rhynochetos jubatus
Endangered

13

9 Limitations to the use of STAR

9.1 Intrinsic limitations of STAR

STAR's flexibility and applicability across geographic scales makes it suitable for a wide range of applications. However, it is important to note that STAR focuses on threatened and near-threatened species. These are regarded as very high priority for conservation attention, but there may be other biodiversity features and aspects of concern or providing opportunities for conservation action. Therefore, STAR may need to be supplemented with additional information to provide a more accurate or complete picture of the biodiversity of an area. This includes data on habitat extent and condition (see Section 8), as well as data for non-threatened species.

STAR's focus on threatened and near-threatened species, particularly those that have small global ranges, may underestimate the biodiversity significance of an area where it supports threatened species not currently assessed through the IUCN Red List (e.g., nationally-listed species not represented in STAR) or widely distributed threatened species. For example, African savannas supporting high numbers of threatened but wide-ranging birds such as vultures and mammals (e.g., large migratory species including elephant, giraffe, hartebeest) may show relatively low STAR values but provide significant opportunities for conservation action. Further, STAR does not capture nationally-listed species or threatened species not currently assessed on the IUCN Red List.

Additional limitations are associated with the IUCN Red List data underpinning the STAR layer. As IUCN Red List updates are periodic, positive species conservation actions on the ground may not be reflected in the Potential STAR layer for some time. Use of site-specific STAR values for establishing the baseline (i.e., 'Potential STAR') and monitoring change through Realised STAR can help address this by generating site-specific values[7]. Use of site-calibrated STAR is also important to assess threats to a specific area. Potential STAR assumes threats are equal across a species' range. It does not account for the magnitude of threats at site level or for undocumented or emerging threats. It is therefore important to understand which threats are relevant to the site and the degree to which they apply.

9.2 Planned improvements

Future iterations of STAR will help address some of the current limitations. Planned improvements include:

- Ability to disaggregate STAR scores for individual species.

- Inclusion of additional taxonomic groups beyond amphibians, birds and mammals, once these groups have been assessed, including freshwater and marine species.

- Integrating additional species for which threat data is currently not available.

- Detailed threat mapping to improve STAR's ability to identify site-specific threats

- Updating and refining species range information to capture spatial variation in species' population density, making it more suitable for site-level mitigation planning.

Periodic recalibration of the Potential STAR layer based on updated IUCN Red List assessments will be made available through IBAT.

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7   Measuring project change requires ongoing monitoring at the intervention site and control sites to be able to distinguish project from background change (see Section 7.2)

Appendix 1 STAR reporting template

IBAT

Integrated Biodiversity Assessment Tool

SPECIES THREAT ABATEMENT AND RESTORATION REPORT
SUMATRA STAR POLYGON

Country: Indonesia

Location: [3.6, 98.3]

Date of analysis: 09 June 2021 (GMT)

Size of site: 1166 km^2

Generated by: Ben Jobson

Organisation: IBAT

Total STAR Threat Abatement score(centiSTAR unit): 2,086.82

Total STAR Restoration score(centiSTAR unit): 1,263.06

Mean STAR Threat Abatement score(centiSTAR unit): 44.4

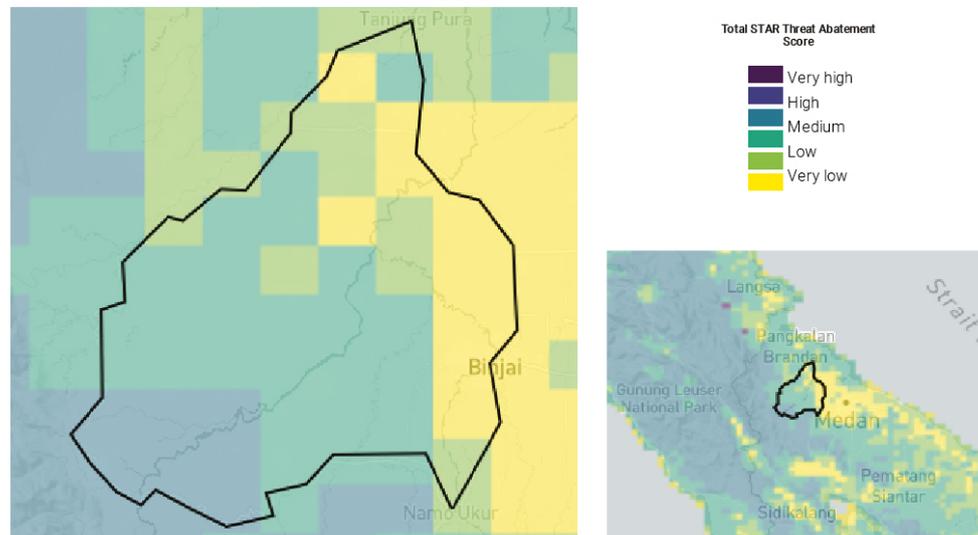**Mean STAR Restoration score(centiSTAR unit): 26.87**

Figure 1: STAR Threat Abatement map for Area of Interest. Grid cell score categories range from Very Low to Very High. Note that low scores do not mean that there are no threatened species present. Grid cells are at a 5km resolution.

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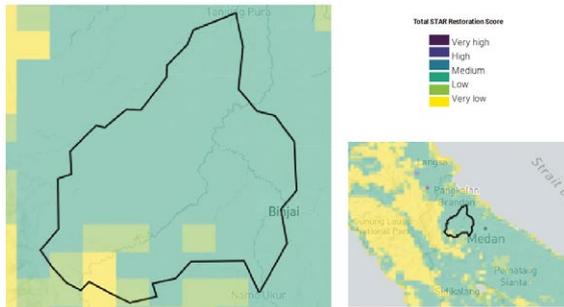

Figure 2: STAR Restoration map for Area of Interest. Grid cell score categories range from Very Low to Very High. Grid cells are at a 5km resolution.

The Area of Interest includes pixels in the top 98% of scores globally for both Threat Abatement and Restoration

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Page 3 (top-right)

Sumatra STAR Polygon's total threat abatement score as a proportion of Indonesia's total threat abatement score

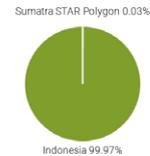Sumatra STAR Polygon 0.03%

Indonesia 99.97%

Figure 3: % contribution of total STAR Threat Abatement score for Area of Interest to total country score.

Indonesia's total threat abatement score as a proportion of Asia's total threat abatement score
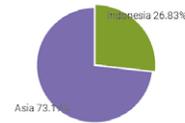

Indonesia 26.83%

Asia 73.1%

Figure 4: % contribution of total STAR Threat Abatement score for country to total continent score.

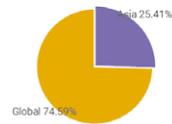### Asia's total threat abatement score as a proportion of the global total threat abatement score

Asia 25.41%

Global 74.59%

Figure 5: % contribution of total STAR Threat Abatement score for continent to global score.

Page 4 (bottom-left)

About this report

This report presents STAR Threat Abatement and Restoration scores for species located within the Area of Interest.

It is part of a package generated by IBAT on 09 June 2021 (GMT) that includes the following files:

1. This PDF report, including maps showing Species Threat Abatement and Restoration scores across the Area of Interest, maps showing STAR scores globally, summary STAR scores for the Area of Interest, and information on STAR and its interpretation.
2. PDF "README" containing recommended use of IBAT and limitations.
3. Compressed CSV file "threat_STAR_scores" containing the breakdown of STAR Threat Abatement and STAR Restoration scores by threat type.
4. Compressed CSV file "grid_cell_threat_abatement_scores" containing the breakdown of the total STAR Threat Abatement scores for each grid cell in the Area of Interest, including coordinates.
5. Compressed CSV file "grid_cell_restoration_scores" containing the breakdown of the total STAR Restoration scores for each grid cell in the Area of Interest, including coordinates.
6. The STAR Guidance Manual
7. STAR Industry Briefing Note
8. The published STAR methodology[1]
9. For IBAT Enterprise subscribers only: Compressed CSV file "STAR_species" containing a list of the individual species present in the Area of Interest that are contributing to the STAR scores. Note that other threatened species in other taxon groups (not amphibians, birds or mammals), and non-threatened species of interest for other reasons, might also be present in the Area of Interest, but are not included in this list.

For information on how STAR is calculated and STAR interpretation, please see sections 1.3 and 1.4. Please note the data caveats in section 1.6. For further context on STAR and its uses, refer to STAR methodology publication, and for commercial users also the STAR Industry Briefing Note and Guidance Manual, all included with this report.

About STAR

STAR scores included in this report are calculated for species of amphibians, birds and mammals for which current or historical area of habitat occurs in the Area of Interest. Species assessed as Near Threatened, Vulnerable, Endangered or Critically Endangered on the IUCN Red List of Threatened Species receive non-zero weightings in calculating the STAR score.

For each 5x5 km grid square, the STAR Threat Abatement score for a species is assessed based on the proportion of current range represented by the grid square, and the species' extinction risk. Adding STAR scores across all species gives the total STAR score for the square. STAR Threat Abatement scores indicate a location's relative potential contribution for biodiversity, specifically for reduction of species extinction risk. Scores can also be broken down to show the relative opportunity to abate the different threats[2] causing species to be at risk of extinction.

STAR Restoration scores are calculated similarly to STAR Threat Abatement Scores, but for areas formerly occupied by a species. They indicate the potential of restoration within a grid cell to reduce species' extinction risk. A global weighting of 0.29 is applied to STAR Restoration scores based on studies of restoration success, to discount for the time taken for restoration and its probability of success.

A site containing 0.5% of the global range of one Vulnerable species will have a STAR Threat Abatement score of 1. A site offering potential to restore an area equal to 1.7% of the global range of one Vulnerable species will have a STAR Restoration score of 1.

How To Use This Report

The report indicates relative potential contribution to biodiversity through mapping and documenting the STAR Threat Abatement and STAR Restoration scores at a 5x5 km resolution. It further breaks down the scores by opportunity to abate principal threats. Scores are presented through categories from "Very Low" to "Very High", but it should be recognised that even in "Very Low" grid cells, there is often still important biodiversity present, and it should not be assumed that these areas have no biodiversity significance.

Uses for this report include:

- Supporting establishment of science-based targets for contributions towards global biodiversity goals
- Screening opportunities for conservation interventions that address threats and/or restore species' habitats
- Assessing current or potential future footprint from land transformation and/or occupancy, and planning mitigation or compensation measures.

For a more detailed understanding of STAR and its uses, including application in other uses such as screening biodiversity risk, please refer to the STAR methodology publication, and, for commercial users, also the STAR Industry Briefing Note. Please also refer to the other datasets, tools and reports available from the IBAT platform to help with interpretation of the outputs from this report.

Threat Abatement Scores

The total STAR Threat Abatement score within the Area of Interest is(centiSTAR unit): 2,086.82
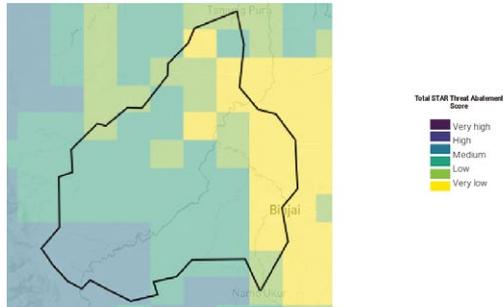

Figure 6: STAR Threat Abatement map for Area of Interest. Grid cell score categories range from Very Low to Very High. Note that low scores do not mean that there are no threatened species present. Grid cells are at a 5km resolution.

STAR Threat Abatement score context

- The total STAR Threat Abatement score for your site comprises 0.03% of the STAR Threat Abatement score for Indonesia.
- Indonesia is in the 100th percentile of national STAR Threat Abatement scores across all countries in the world.
- The total STAR Threat Abatement score for Indonesia comprises 26.83% of the continental STAR Threat Abatement score. The continental STAR Threat Abatement score in turn comprises 25.41% of the total global STAR Threat Abatement score.
- The maximum grid-cell Threat Abatement score for your site is in the 90th percentile of grid-cell scores nationally and the 99th percentile of grid-cell scores globally. Its relative classification is Medium. A breakdown of your Threat Abatement score by different threat types is provided in Table 1
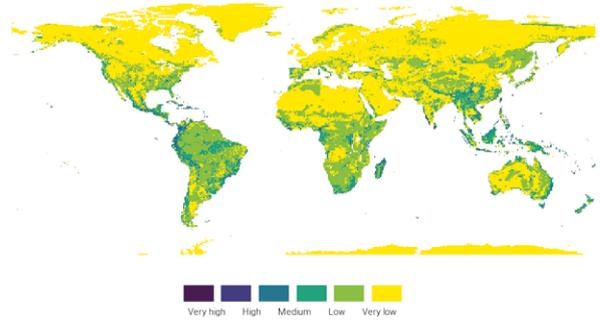

Figure 7: Global STAR Threat Abatement map. Grid cell score categories range from Very Low to Very High. Note that low scores do not mean that there are no threatened species present. Grid cells are at a 5km resolution.

Table 1: Summary table of STAR Threat Abatement scores within the Area of Interest. Scores are broken down by the different threat types and their relative contributions to the overall score. For more information on the IUCN threat categories, see IUCN Threat Classification Scheme.

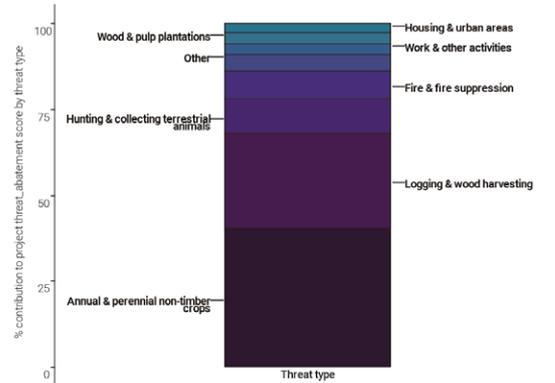| Threat type	Total Threat Abatement score across Area of Interest(centiSTAR unit)	% of overall Threat Abatement score for Area of Interest	Mean(maximum) STAR Threat Abatement score per grid square(centiSTAR unit)
Annual & perennial non-timber crops	846.564	40.57	7.30696
Logging & wood harvesting	577.112	27.66	3.39577
Hunting & collecting terrestrial animals	210.39	10.08	0.4513
Fire & fire suppression	168.214	8.06	0.2885
Other	98.25	4.71	0.01507
Work & other activities	66.318	3.18	0.04484
Wood & pulp plantations	63.306	3.03	0.04086
Housing & urban areas	56.664	2.72	0.03274

Figure 8: Breakdown of STAR Threat Abatement scores within the Area of Interest by threat type.

17

Restoration Scores

The total STAR Restoration score within the Area of Interest is(centiSTAR unit): 1,263.06

Total STAR Restoration Score
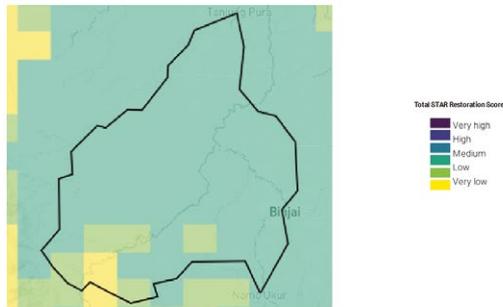- Very high
- High
- Medium
- Low
- Very low

Figure 9: Global STAR Restoration rankings map for Area of Interest. Grid cell score categories range from Very Low to Very High, and reflect the range of values found within the site in the global context. Grid cells are at a 5km resolution.

STAR Restoration score context

- The total STAR Restoration score for your site comprises 0.06% of the STAR Restoration score for Indonesia.
- Indonesia is in the 97th percentile of national STAR Restoration scores across all countries in the world.
- The total STAR Restoration score for Indonesia comprises 12.34% of the continental STAR Restoration score. The continental STAR Restoration score in turn comprises 23.12% of the total global STAR Restoration score.
- The maximum grid-cell Restoration score for your site is in the 95th percentile of grid-cell scores nationally and the 98th percentile of grid-cell scores globally. Its relative classification is Low. A breakdown of your Restoration score by different threat types is provided in Table 2
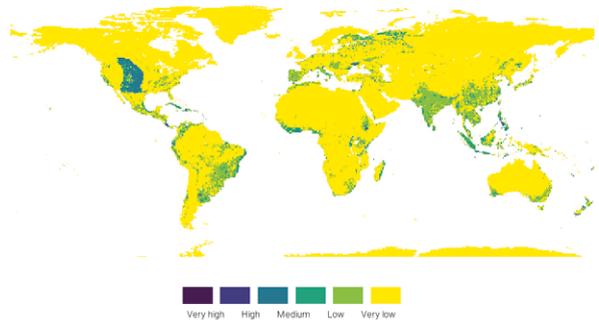

Very high · High · Medium · Low · Very low

Figure 10: Global STAR Restoration map. Grid cell score categories range from Very Low to Very High. Grid cells are at a 5km resolution.

Table 2: Summary table of STAR Restoration scores within the Area of Interest. Scores are broken down by the different threat types and their relative contributions to the overall score.

| Threat type	Total Restoration score across Area of Interest(centiSTAR unit)	% of overall Restoration score for Area of Interest	Mean(maximum) STAR Restoration score per grid square(centiSTAR unit)
Annual & perennial non-timber crops	509.607	40.35	4.37472
Logging & wood harvesting	346.343	27.42	2.02066
Fire & fire suppression	105.466	8.35	0.18737
Hunting & collecting terrestrial animals	103.825	8.22	0.18159
Other	57.118	4.52	0.00834
Work & other activities	45.426	3.6	0.03476
Housing & urban areas	40.617	3.22	0.02779
Wood & pulp plantations	38.801	3.07	0.02536
Roads & railroads	15.853	1.26	0.00423
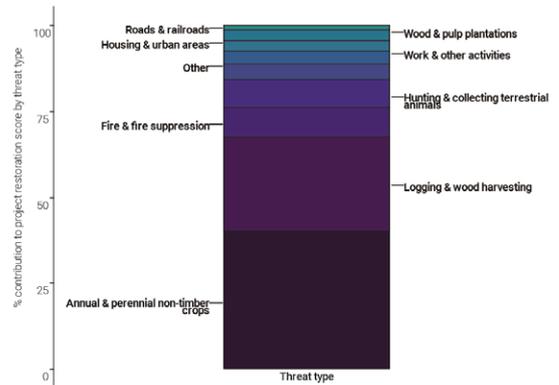
Figure 11: Breakdown of STAR Restoration scores within the Area of Interest by threat type.

18

Appendix 2
IUCN Threat Classification Scheme used in STAR

Threat type	Definition
1. Residential & Commercial Development	Threats from human settlements or other non-agricultural land uses with a substantial footprint
2. Agriculture & Aquaculture	Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture and aquaculture (includes the impacts of any fencing around farmed areas)
3. Energy Production & Mining	Threats from production of non-biological resources, including oil and gas, mining and renewable energy
4. Transportation & Service Corridors	Threats from long narrow transport corridors and the vehicles that use them including associated wildlife mortality
5. Biological Resource Use	Threats from consumptive use of "wild" biological resources including both deliberate and unintentional harvesting effects; also persecution or control of specific species
6. Human Intrusions & Disturbance	Threats from human activities that alter, destroy and disturb habitats and species associated with non-consumptive uses of biological resources
7. Natural System Modifications	Threats from actions that convert or degrade habitat in service of "managing" natural or semi-natural systems, often to improve human welfare
8. Invasive & Other Problematic Species, Genes & Diseases	Threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance
9. Pollution	Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources
10. Climate Change & Severe Weather	Threats from long-term climatic changes which may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation, or potentially can wipe out a vulnerable species or habitat

Glossary

Area of Interest (AoI): the user-defined location or polygon.

Area of Habitat (AoH): Modelled species' area of habitat, based on IUCN Red List data on species' ranges, along with species' habitat associations and elevation limits.

The IUCN Red List of Threatened Species™ **(or IUCN Red List):** international standard for assessing species extinction risk. The IUCN Red List is compiled by IUCN's global network of experts, specialist groups and partners. For further information, please see The IUCN Red List of Threatened Species website. IUCN Red List categories used in STAR calculation are:

- **Critically Endangered (CR):** Highest risk of extinction. A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered, and it is therefore considered to be facing an extremely high risk of extinction in the wild.

- **Endangered (EN):** Very high risk of extinction. A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.

- **Vulnerable (VU):** High risk of extinction. A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable, and it is therefore considered to be facing a high risk of extinction in the wild.

- **Near Threatened (NT):** Risk of extinction. A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered, or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.

Keel-billed Toucan
Ramphastos sulfuratus
Least Concern

IBAT

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