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LIVING PLANET REPORT 2020

A DEEP DIVE INTO THE LIVING PLANET INDEX

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Founded in 1826, ZSL (Zoological Society of London) is an international conservation charity working to create a world where wildlife thrives. ZSL's work is realised through ground-breaking science, field conservation around the world and engaging millions of people through two zoos, ZSL London Zoo and ZSL Whipsnade Zoo.

ZSL manages the Living Planet Index® in a collaborative partnership with WWF.

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The spinner dolphins thrive off the coast of Costa Rica where they feed on lanternfish.

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We would also like to thank everyone who kindly added data to the Living Planet Database (www.livingplanetindex.org).

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A DEEP DIVE INTO THE LIVING PLANET INDEX

INTRODUCTION

Species population trends are important because they are a measure of overall ecosystem health. Measuring biodiversity is complex, and there is no single measure that can capture all of the changes in this web of life. Nevertheless, the vast majority of indicators show net declines over recent decades. The global Living Planet Index, the flagship indicator for the *Living Planet Report*, shows an average 68% decrease in population sizes of mammals, birds, amphibians, reptiles and fish between 1970 and 2016. Here, we look at the data behind the LPI and explain in more detail how the trends presented in the report are calculated.

A group of California sea lions (*Zalophus californianus*) swimming in kelp forest (*Macrocystis pyrifera*), California, USA.


© naturepl.com / Pascal Kobeh / WWF

THE LIVING PLANET INDEX AT A GLANCE

What is the Living Planet Index?

Valentina Marconi, Louise McRae, Stefanie Deinet, Sophie Ledger, Robin Freeman (Zoological Society of London - ZSL)

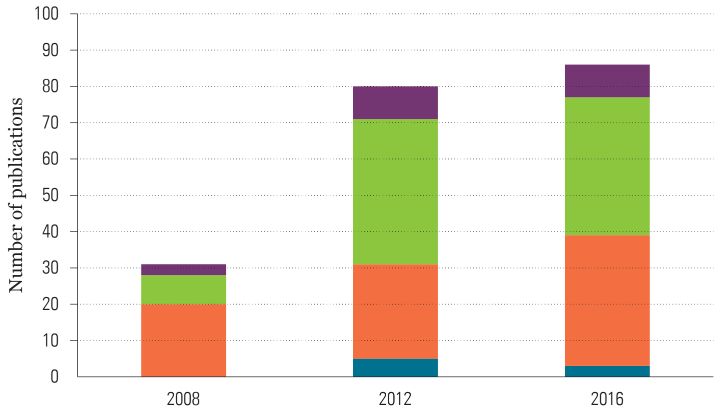
The LPI is one of a suite of global indicators used to monitor progress towards the Aichi Biodiversity Targets agreed by the Convention on Biological Diversity (CBD) in 2010. These targets are set for review this year, in 2020, the 'super year' for biodiversity. Aichi Targets require nations to take effective and urgent action to halt the loss of biodiversity and ensure that ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human well-being and poverty eradication.

The LPI tracks trends in abundance of a large number of populations of vertebrate species in much the same way that a stock market index tracks the value of a set of shares or a retail price index tracks the cost of a basket of consumer goods. The data used in constructing the index are time-series of either population size, density (population size per unit area), abundance (number of individuals per sample) or a proxy of abundance (for example, the number of nests recorded may be used instead of a direct population count). The LPI is currently based on time-series data for 20,811 populations of 4,392 species of mammals, birds, reptiles, amphibians and fish from around the globe. Using a method developed by ZSL and WWF, these species population trends are aggregated and weighted to produce the different Living Planet Indices.

Figure 1:
Number of publications that used the LPI method or data (purple), mentioned the LPI (green), cited LPI figures (red) or discussed the indicator in 2008, 2012 and 2016.

Key

- Brief mention / cited
- Discussed
- Figures cited
- Method / data used



What the LPI has been used for and how it has evolved

The LPI database is continually evolving as we add data for an increasing number of species and countries every year. By collecting additional information alongside species population trends – such as the type of species monitored, or where it lives – we can increase the value of the LPI data beyond just the statistics, producing a more in-depth view of the changes in species around the world. The data and the methodology used to calculate the LPI have been increasingly used in a variety of scientific outputs (Figure 1) to look at population trends in different taxa, regions and groups of species.

For a full list of LPI publications, please visit https://livingplanetindex.org/publications.

The LPI data, and tools for analysis, have also been used in both international and national policy and integrated into education programmes and public engagement events. The following are some important examples of how the LPI data has been used:

A closer look at population trends for different species and regions

Population trends vary among types of species and regions. Using LPI data we have been able to look at trends for a number of species groups such as mammals [1] and migratory birds [2]. In each case the factors behind the trends – such as body size, habitat and environmental variables – were explored. LPIs for two very different regions – the Arctic [3] and Mediterranean wetlands [4] – have been produced, showing average trends among species in those regions since 1970. The first LPI for reptiles was also recently published [5].

The impact of conservation on species

Population trend data, the building blocks of the LPI, can be used to understand if, and how, conservation is benefitting species. This approach has been used to examine the drivers behind the comeback of some species in Europe over the past 50 years [6] and to assess how the use of protected areas in conservation can benefit species [7-10].

The impact of threats on species
There are many types of threats that can affect species, and by investigating the relationships between population trends and threats we can start to understand which species are most vulnerable and where. The LPI data has been used to explore how land-use change and climate change relate to trends in birds and mammals [11], as well as how trends in species that are used – for food, medicine, etc – have fared since 1970 [12]. More recently, a focus on forest species revealed how more than one threat can affect species, and that concentrating on just one threat may mean an important part of the picture is missed [13].

Tracking progress towards international policy targets
The LPI has been used to measure progress towards international biodiversity targets set by the Convention on Biological Diversity [14,15] as well as national-level targets [16,17]. It was also incorporated in the IPBES global assessment [18], and a recent study looked at how population data from the LPI relates to other targets under the Sustainable Development Goals [19].

Educating and inspiring
With a bank of thousands of species population trends, the LPI database has been a useful resource for student training at undergraduate and postgraduate level, through both formal teaching and independent research projects. The LPI has also functioned as a talking point for public engagement events held for everyone from children to scientists to engage people in conversations about the natural world and how to conserve it.

What subsets of the global LPI are included in the 2020 Living Planet Report?

In addition to the global LPI, the 2020 report contains LPI subsets to reflect trends in:

A) Terrestrial and freshwater populations in the IPBES regions – Africa, Americas (North and Latin America & Caribbean), Asia-Pacific, Europe-Central Asia
B) Freshwater species
C) Forest specialist species
D) European butterflies
E) Reptiles

A) Terrestrial and freshwater populations in the IPBES regions – Africa, Americas (North and Latin America & Caribbean), Asia-Pacific, Europe-Central Asia

Previous LPRs have analysed trends across biogeographic realms (geographic regions combined with the historic and evolutionary distribution patterns of terrestrial plants and animals). However, in 2020, the landmark year for biodiversity, the LPI has instead been applied to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) regions, to allow for easy comparisons of trends (Figure 2). The IPBES regions differ slightly as they reflect sociopolitical boundaries, and within this report North and South America are analysed separately to reflect their significantly different biodiversity and LPI trends. In the report, a breakdown of the threats affecting species populations in the different regions is also presented. This information is collected from the data sources when the data are entered in the LPI database, and is specific to the monitored populations.

Figure 2:
The IPBES regions map: IPBES (2015)[37].

B) Freshwater species

In the Living Planet database, each population is assigned to one system – terrestrial, freshwater or marine. This is typically based on the main habitats in which the species occurs. For some species, however, this might be difficult to assign; these species are therefore assigned to the system in which they were monitored. For example, Pacific salmon will be assigned to marine if monitored in the ocean and freshwater if monitored in a river. The freshwater LPI consists of 944 birds, mammals, amphibians, reptiles and fish monitored in freshwater habitats such as rivers and wetlands.

C) Forest specialist species

Using the LPI data, we can monitor changes in population abundance for forest specialist species. The Forest Specialist LPI shows the abundance trends for 455 monitored populations of 268 bird, mammal, reptile and amphibian species that only live in forests. We defined forest specialists using the habitat coding from the IUCN Red List [20]. Those with "Forest" listed as one of the major habitats were considered forest generalists, while those with only "Forest" listed as the major habitat were considered forest specialists. This definition of specialist is rather conservative, as the "Forest" category from the IUCN Red List refers to natural habitat and does not include artificial habitats such as plantations.

D) European butterflies

Although at present the LPI contains data only for vertebrate species – as, historically, these have been better monitored – efforts are underway to incorporate data on invertebrates, starting with insects. For the 2020 edition of the *Living Planet Report*, a subset of this charismatic order of insects, still underrepresented in the Red List of Threatened Species, has been included in the analysis. An LPI has been calculated for 17 typical grassland butterfly species for 16 European countries between 1990 and 2017.

E) Reptiles

Among vertebrates, reptiles have been one of the lesser studied groups, despite having one of the highest total number of species. Recently, a few studies have tried to redress the balance; one of which has shown that one in five species of reptiles is threatened with extinction [21]. The LPI for reptiles contains 672 population time-series representing 227 species across the globe.

What are the main trends shown by the LPI?

The headline trend from this *Living Planet Report* is that globally, monitored populations of birds, mammals, fish, reptiles and amphibians have declined in abundance by 68% on average between 1970 and 2016.

The headline trend from this *Living Planet Report* is that globally, monitored populations of birds, mammals, fish, reptiles and amphibians have declined in abundance by 68% on average between 1970 and 2016. The results also indicate that species are faring much worse in freshwater systems, where vertebrate populations declined by an average of 84%. In order to highlight geographical differences, regional LPIs have also been calculated. These trends have been defined slightly differently to previous years. Following the IPBES regional classifications, terrestrial and freshwater populations within a country were assigned to an IPBES region and a trend was then calculated for each region. The main trends reported in the LPR are listed in Table 1. A more in-depth discussion of some of these trends is presented below.

		Number of species	Number of populations	Percentage change 1970 - 2016	95% confidence limits	
					Lower	Upper
Global	Global	4,392	20,811	-68%	-73%	-62%
Systems	Freshwater	944	3,741	-84%	-89%	-77%
IPBES regions	Africa	371	1,318	-65%	-78%	-43%
	North America	944	2,473	-33%	-54%	-4%
	Latin America & Caribbean	761	1,159	-94%	-96%	-89%
	Asia-Pacific	581	2,167	-45%	-65%	-15%
	Europe-Central Asia	608	4,283	-24%	-43%	2%
Forest specialist species		268	455	-53%	-70%	-27%
Reptiles		227	672	-31%	-61%	19%
Grassland butterflies	Europe	17	17	-49%	-71%	-13%

Table 1:
Trends in the Living Planet indices between 1970 and 2016, with 95% confidence limits. Positive numbers indicate an increase, negative numbers indicate a decline. Please note that the European Grassland Butterfly Index spans the years between 1990 and 2017, and the Forest Specialist Index stops at 2014 due to data availability. WWF/ZSL (2020)[22].

Zooming in on population trends in the IPBES regions

The Americas

The Americas are highly biologically diverse, hosting the largest number of megadiverse countries (the most biodiversity-rich countries that also harbour high numbers of endemic species) of any continent in the world [23]. The region has a large capacity to provide for people, while at the same time supporting only 13% of the total human population.23 Despite this seemingly favourable balance between capacity and demand, the region also accounts for around 23% of the global ecological footprint [23]. Between 1970 and 2016, the LPIs for North America and for the remaining subregions combined (South America, Mesoamerica and the Caribbean) have declined by an average of 33% (2,473 populations of 944 species; range: -54% to -4%) and 94% (1,159 populations of 761 species; range: -96% to -89%) respectively. After an initial steady decrease, the North American trend appears to stabilize from the turn of the millennium. This flattening of the line suggests that the rate of decline is slowing, and continued monitoring will show whether this is true across all species groups. The situation appears to be much more serious in the tropical subregions of the Americas. The 94% decline in Latin America & Caribbean is the most striking decline observed in any IPBES region. The conversion of grasslands, forests and wetlands, the overexploitation of species, climate change, and the introduction of alien species [23] have all contributed to a precipitous decline in biodiversity in this area of the globe. Figures for fish, reptiles and amphibians are behind much of the decline. Preliminary analysis suggests that the largest decline in the LPI can be seen in the Mesoamerica subregion, but additional data is needed to assess whether this extends to other tropical subregions (South America, Caribbean).

Europe and Central Asia

Europe-Central Asia not only has one of the highest Ecological Footprints of any IPBES region but also exceeds its biocapacity by the largest amount [24]. However, the abundance trend monitored here – of 4,283 populations, representing 608 species – shows the smallest decline of any IPBES region: the average decline is 24% between 1970 and 2016 (range: -43% to 2%). This figure paints a less severe picture for the biodiversity of Europe-Central Asia, and can be attributed in part to successful conservation efforts during the time period. That said, biodiversity had been transformed to a large degree prior to 1970, especially in Western Europe, so the LPI shows trends from many species that were already in a depleted state. A closer look at the Europe-Central Asia subregions suggests that Eastern European populations have not fared as well.

Africa

The region of Africa is very rich in biodiversity and is the only remaining region on Earth to still have significant numbers of large mammals [25]. The goods and services that Africa's biodiversity provides are important, not only for Africa but for the rest of the world [25]. The LPI for the Africa IPBES region has decreased in abundance by 65% on average (range: -78% to -43%) between 1970 and 2016, based on monitoring data from 1,318 populations of 371 species. More information is needed to examine trends in different subregions, but initial examination suggests declines in West, Central and East Africa, and more stable trends at the extremes of the continent in North and Southern Africa. These results largely correspond with the findings of the Red List Indices for the Africa subregions [25].

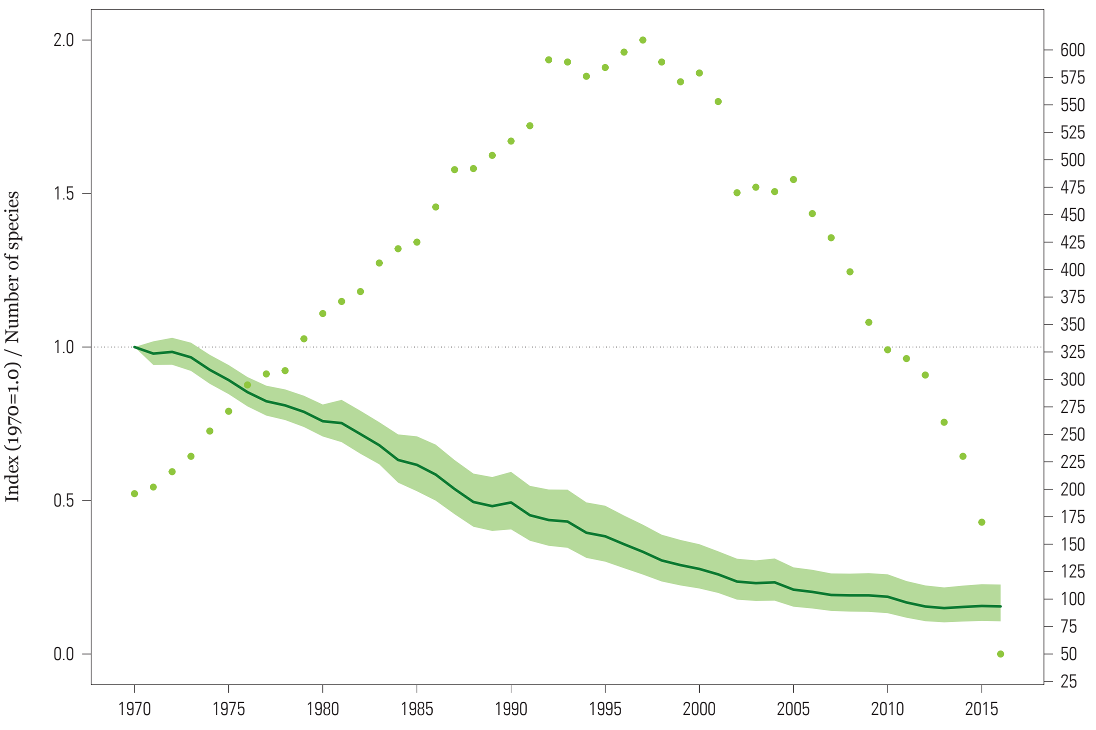
Asia-Pacific

The Asia-Pacific region comprises both vast terrestrial plains and many islands small and large, leading to a huge number of endemic species and unique ecosystems [26]. Species populations monitored in the Asia-Pacific region have steadily decreased on average since 1970, although there has been a positive trend since 2010, which is also seen in a few species of reptiles and amphibians. Overall abundance is 45% lower on average by 2016 (range: -65% to -15%). Because most species were monitored in the Oceania subregion, its trend is very similar, although declines appear to be happening in all other subregions.

Is the decline in freshwater populations slowing down?

The 84% decline in freshwater populations globally is one of the most striking declines presented in the *Living Planet Report*. This is a further reduction since the index was last published in the LPR 2018, when it showed a decline of 83%. Since the 2018 report, 554 populations of 194 freshwater species have been added to the database; 71 of these are new species to the LPI. The updated version contains two more years of data but also new time-series throughout the considered time frame. The trend appears to stabilize over the last few years for which we have data (2012-2016). A taxonomic disaggregation of the Freshwater LPI (not shown) highlighted how this stable trend, rather than being a generalized trend for all species, is the result of a flattening of the fish and bird indices, combined with a slight increase in the amphibian and reptile index between 2013 and 2016, and a sharp drop followed by a sharp increase in the mammal index. More data collection is needed to confirm if these are genuine trends. In Figure 3 the trend is shown alongside the number of species contributing to the index in each year: this drops considerably over the last few years of the trend, and especially in 2016. This is not unusual in LPI trends as there is often a lag between when data are collected, and when they are integrated into the LPI database. This reflects the time it takes to analyse and publish data in scientific journals, the main source of data for the Living Planet Index database.

Figure 3:
Index of abundance for 944 freshwater vertebrate species (final index value = -84%; range = -77% to -89%) monitored between 1970 and 2016, and the number of species contributing to the index in each year (pale green dots). WWF/ZSL (2020)[22].



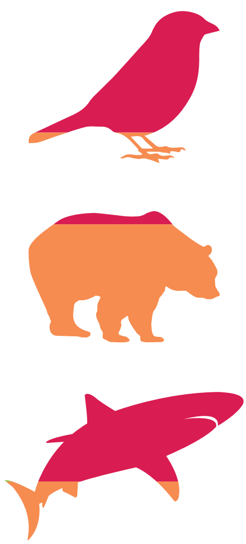
Fish heading upstream in the Juruena River,
Salto São Simão, Mato Grosso-Amazonian States, Brazil.

INTERPRETING THE RESULTS

Framing the LPI: Why should we be using the word 'decline' instead of 'loss'?

Although the LPI uses time-series of either population size, density, abundance or a proxy of abundance, the overall trend calculated represents an average trend in population change and not an average of total numbers of individual animals or species lost. Figure 4 explains this difference using three example populations of three different species, all of which declined but by different percentages. The tables show that although the average percentage change of the trend represented is 50%, the total number of animals in the three combined populations has not declined by this much, so we haven't lost 50% of animals.

Figure 4:
An illustration of how the average percentage change of the trend differs from the change in total number of animals lost (in percentage). WWF/ZSL (2020)[22].



	Bird population	Bear population	Shark population
Initial population size	25	50	20
Final population size	5	45	8
Number of animals lost	20	5	12
Percentage change	-80%	-10%	-60%

Initial population size (total)	95
Final population size (total)	58
Number of animals lost (total)	37
Number of animals lost (%)	39%
Percentage change (average)	-50%

What does the LPI indicate?

LPI results are calculations of average trends. This means that for the global LPI some populations and species have declined by more than 68%, whereas others have not declined as much – or are even increasing. The average trend calculated for each species in the LPI shows that just over half of reptile, bird and mammal species are stable or increasing (Figure 5). Conversely, the average trend for over 50% of fishes and amphibian species shows a decline.

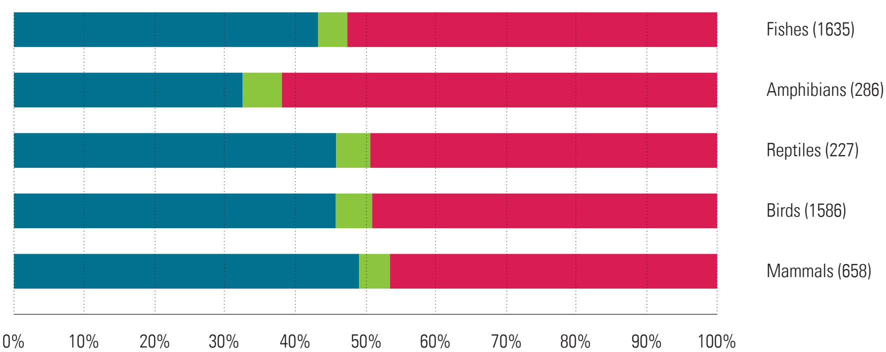
As the number of species which have positive and negative trends are more or less equal, this means that the magnitude of the declining trends exceeds that of the increasing trends in order to result in an average decline for the global LPI. This also suggests that the global LPI is not being driven by just a few very threatened species, but that there are a large number of species in each group (almost 50%) that together produce an average declining trend.

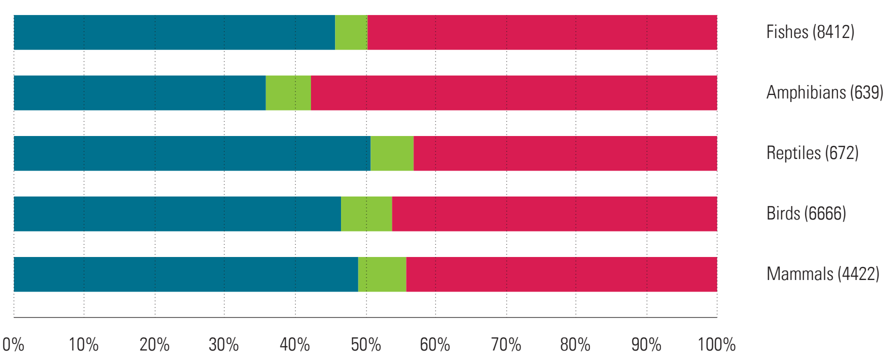
If we look at trends at the population level a similar pattern emerges, although in this case amphibians are the only taxonomic group with over 50% of populations showing a negative trend.

Figure 5:
The proportion of species (above) and populations (below) in each taxonomic group where the average trend is an increase (blue), is stable (green) or a decline (red). WWF/ZSL (2020)[22].

Key

Increase
Stable
Decline





What is the LPI useful for?

Distilling many trends into a global mean index can of course mask variation. As mentioned above, not all populations in the LPI are declining rapidly, and some are increasing. This is why we also subset the data to show sub-indices for different regions and taxonomic groups. It's important to show how the species within these subsets vary, and to capture the uncertainty of these trends. Several scientific studies have explored this research topic to try and uncover trends in vertebrate populations and how they vary according to location, species ecology and types of threats the species are affected by [27,5,11,19,13].

The global LPI trend is also an important tool in communicating to policymakers and to the general public, to catalyse attention and encourage a broader conversation around biodiversity loss. The LPI is one of the best tools we have for outlining the global situation, in the same way as changes in the FTSE All-Share Index give a sense of how the economy is faring (but tell us nothing about employment rates or fairness in salary distribution). Without digging into the detail, it also doesn't tell us about which sectors are doing well or not doing well. Similarly, GDP tells us something about the state of the economy so it has a certain 'overview' value, despite its well-publicized shortcomings.

A red howler monkey (*Alouatta seniculus*), South America.

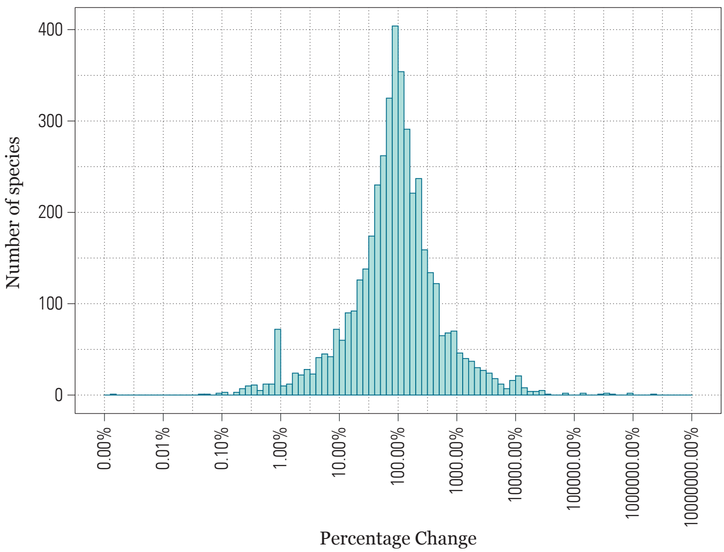
© Martin Harvey / WWF

TESTING THE SENSITIVITY OF THE LIVING PLANET INDEX

Do outliers and extreme trends have a strong influence on the LPI value?

The geometric mean, the metric the LPI is based on, can be sensitive to extreme values and outliers [28,29], both positive and negative. To some extent this is not surprising. If we remove the figures for the top-performing companies in the FTSE All Share Index, or the worst-performing companies, then, inevitably, the FTSE figure would change. While it is useful to identify the populations that are most in decline, excluding these from the remaining populations is complex. We are currently investigating how increasing the representation of our dataset can help mitigate some of the sensitivities of the analysis to extreme increases and declines in individual populations. If we look at the total change between 1970 and 2016 for the species included in the global LPI (Figure 6), we can see that – as expected – fewer species exhibit extreme increases or declines compared to the number of species that show stable trends or moderate increases and declines.

Figure 6: Histogram of the total change between 1970 and 2016 of the 4,392 species contributing to the global LPI
Species are binned based on the magnitude of the total change they go through during the entirety of the time-series (one or more) they are represented by in the dataset. : "100%" is the size of the species population at the beginning of the time-series, so the frequency at "100%" represents time series with no change in population size (stable population). The remaining percentages reflect how many times larger or smaller the species populations are compared to the beginning of the time series. WWF/ZSL (2020)[22].



What influence do short time-series have on the LPI trend?

The LPI database contains data gathered from different sources and collected at different scales, and not explicitly for the purpose of the analyses presented in the *Living Planet Report*. It therefore consists of time-series of varying lengths (interval between the first and the last observation) and fullness (number of observations during the time-series). For some species/groups, only shorter time-series are available, as shown in Figure 7. While time-series for birds and mammals are longer, amphibians are almost exclusively represented in the database by shorter time-series. If we only collected and used long-term data, which is often available for species/groups that are doing relatively well, we could potentially miss declines in other species, which are important signals from a conservation perspective. Also, a recent study comparing known long-term trends in bird abundance with samples of these complete time-series[30] suggests that if a significant trend is detected in the sample it is likely to reliably describe the direction (positive or negative) of the complete trend. Although it remains to be tested if these results can be expanded to other taxonomic groups and types of data, this might suggest that a decline detected in a short time-series is worth investigating to confirm the trend and potentially avoid further decline.

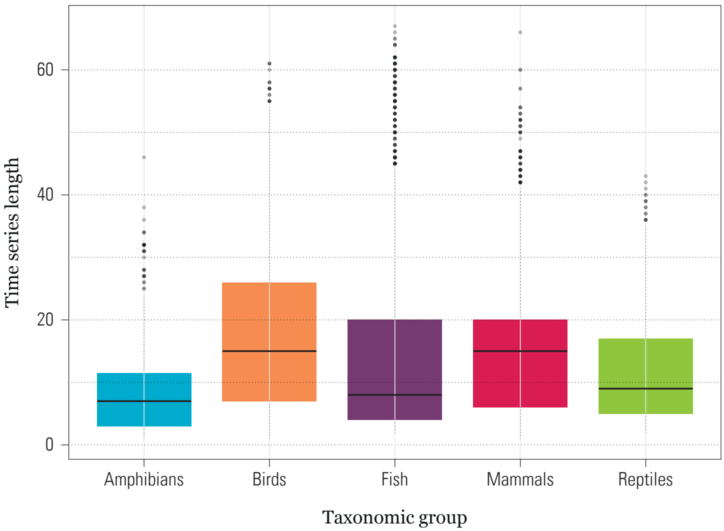
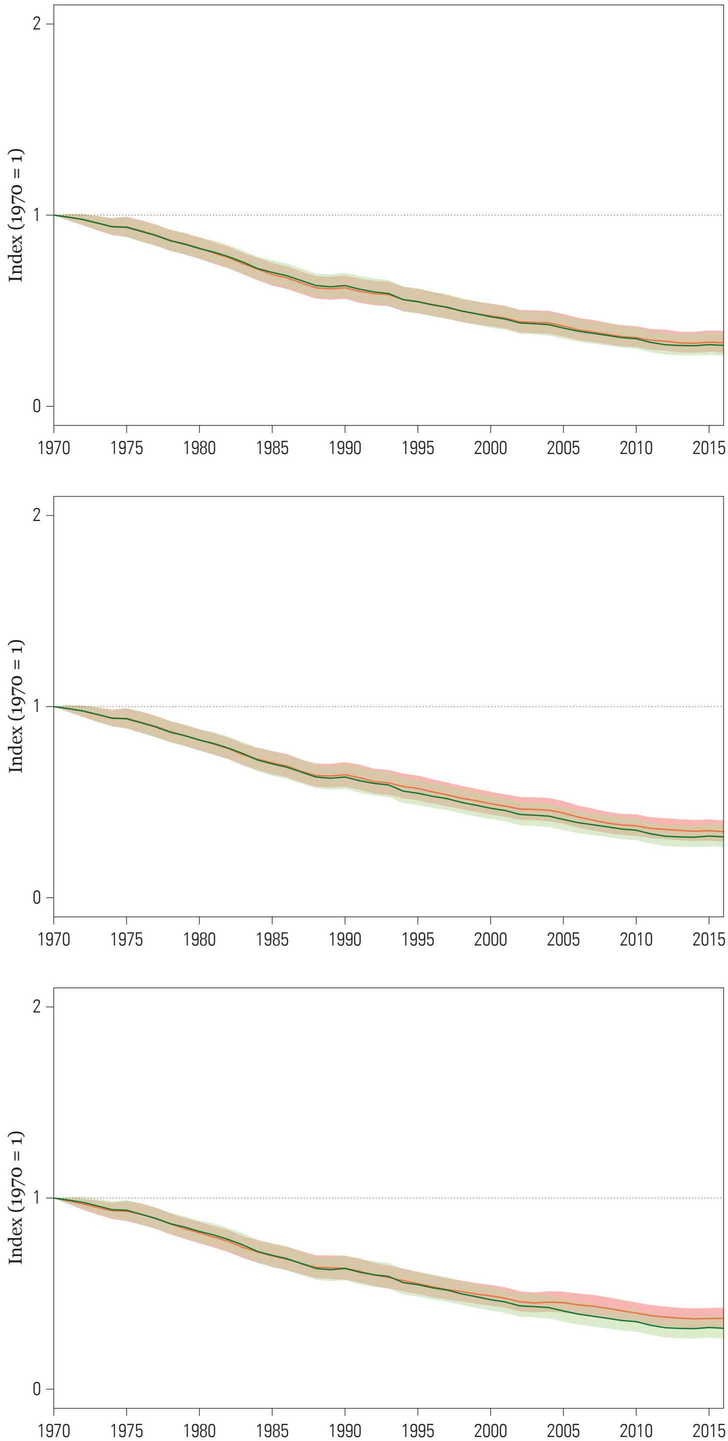


Figure 7:
Boxplot showing time-series length by taxonomic group, WWF/ZSL (2020)[22].

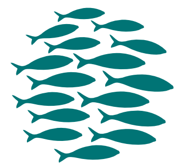
Figure 8:
Indices of abundance for vertebrate species monitored between 1970 and 2016, calculated excluding time-series with data covering less than 3 years (top, 19,470 populations of 4,094 species), 5 years (middle, 16,579 populations for 3,760) and 10 years (bottom, 12,180 populations of 3,179 species). The global LPI trend is provided for comparison (in green). WWF/ZSL (2020)[22].



To gauge whether the inclusion of these shorter time-series might be skewing the results of the global LPI, we recalculated the trend excluding short time-series (Figure 8). Overall, the removal of shorter time-series appears to have little influence on the overall trend, with the trend calculated excluding time-series with less than 3 years of data largely overlapping with the global trend. Trends calculated excluding time-series with less than 5 and 10 years of data diverge from the global trend from 2002 and 2003, respectively. However, the confidence intervals around these trends overlap for the most part with the confidence intervals around the global trend, and the final index values differ from the final value of the global trend by 3% and 5% respectively.

Why do different indicators show different results?

The LPI measures change in the abundance of species over time, but this is only one aspect of biodiversity – other indicators take different approaches to estimating the trends in global biodiversity. The Biodiversity Intactness Index (BII), for example, shows a less steep decline than the LPI over a similar time period[31]. The BII describes change in local richness: specifically it estimates how much of a region's originally present biodiversity remains, relative to if the region were still covered with primary vegetation and facing minimal human pressures. The fact that the BII value is lower than the LPI is due to a number of differences in data types and datasets used, and methodology. The BII is based on data from a larger number of species (47,000), and therefore examines the status of a broader set of taxa than most other indicators, including the LPI. In terms of data types, the BII uses species composition in addition to abundance, which is different to the LPI. And in terms of methodology, it not only substitutes space for time (i.e. it doesn't measure over time like the LPI), it makes certain assumptions and extrapolations in its calculation, which may lead to an underestimation of losses (see Martin, P.A. *et al.* (2019)[32]) and, specifically, extirpations. Because the trend calculated for the BII describes the total number of individuals, it uses an arithmetic rather than a geometric mean, and may thus be particularly influenced by abundant species.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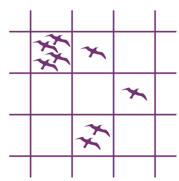
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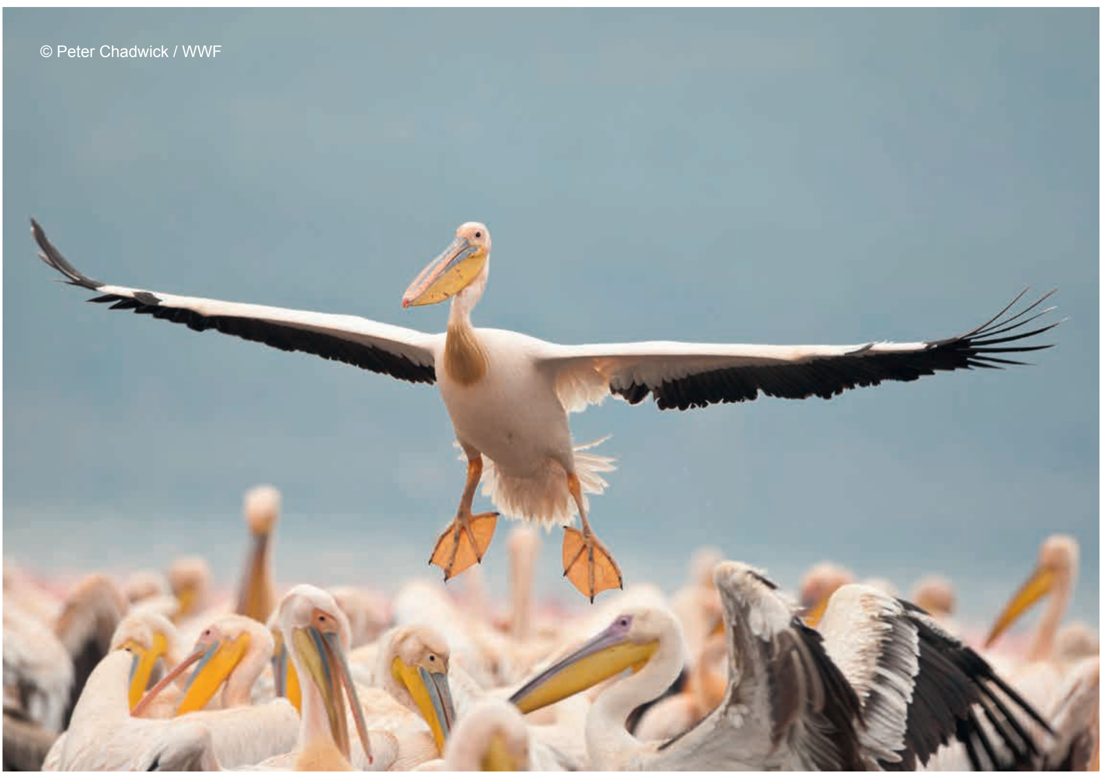
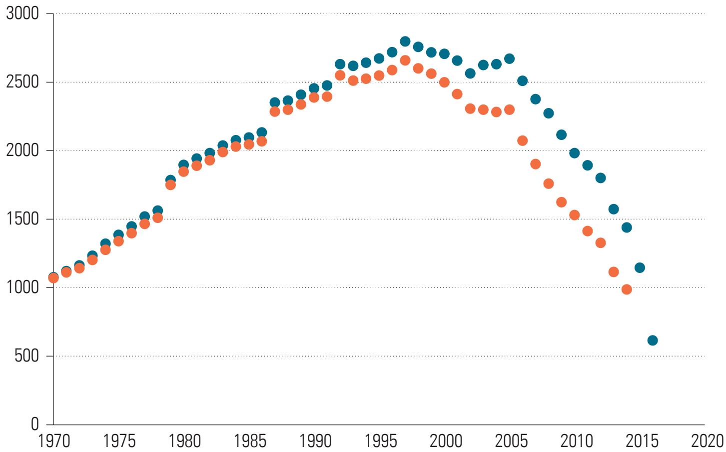
EXTINCTION RISK


COMPOSITION

Why do percentages reported for LPIs change from year to year?

The global LPI shows a declining trend, as has also been seen in earlier editions of the *Living Planet Report*. However, the magnitude of the trend is different than in previous years. The reason for this is that the dataset is continually evolving and for each *Living Planet Report* a larger dataset is available for analysis (Figure 9). Data for the LPI are gathered from a variety of sources such as journals, online databases and government reports that contain time-series of vertebrate populations spanning any number of years between 1970 and 2016. A different composition of species and populations means that the average value of each LPI can change. Some of these new populations and species will add more information to more recent years, so that indices can be extended by two years, as is usually the case with each new edition of the report. The new percentages generally stay within or close to the range (as measured by the confidence limits) of previous results so there are similar overall trends even if the final percentage value is often different.





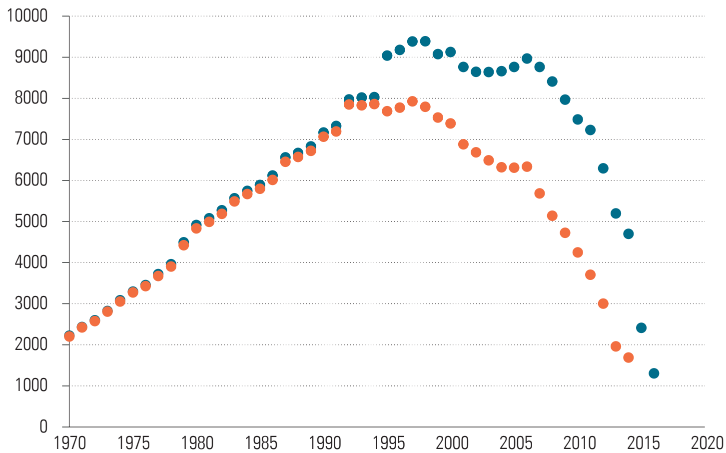


Figure 9:
The number of species (above) and populations (below) contributing to the index in each year for both the 2018 (orange) and 2020 (blue) Living Planet Report. WWF/ZSL (2020)[22].

Key

2018
2020

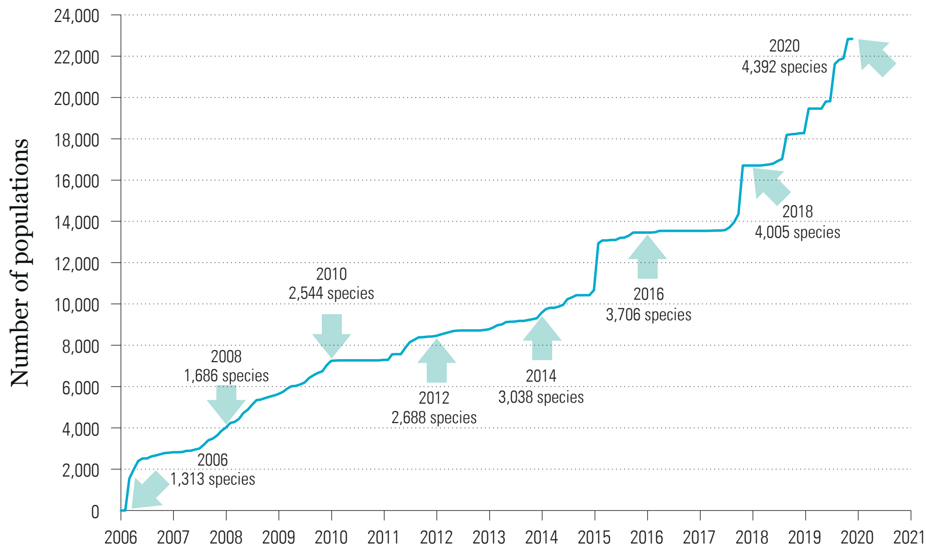
A great white pelican (*Pelecanus onocrotalus*) in Lake Nakuru National Park, Kenya.

THE LPI DATABASE

How many species and populations are there in the LPI?

The LPI database currently contains over 27,000 populations of more than 4,700 species from around the globe. The global LPI is based on 20,811 of these populations, focusing on 4,392 species of mammals, birds, reptiles, amphibians and fish. Since the last edition of the *Living Planet Report* in 2018 the size of the dataset has increased by 25% in terms of populations, and 10% in terms of species (Figure 10). These changes have also improved the spread of the data among different taxonomic groups and realms (Tables 2 and 3). Most of the new species (38%) are fish species, followed by amphibians (25.5%) and birds and mammals (15% each), while a much smaller proportion of reptiles has been added to the dataset. The majority of new populations have been added to mammals (34.5% more compared to LPR 2018) and birds (34%). Around 15% of the new species added since the 2018 LPR – mostly birds – are from monitoring locations in Australia. These data were collected as part of a project aimed at developing a Threatened Species Index [33] at the national level. Panama, Taiwan and the Russian Federation also contributed a considerable number of species. The remainder are species from tropical areas as data collection was focused there to improve representation. A list of the new species can be found here: http://stats.livingplanetindex.org/.

Figure 10:
The cumulative number of population time-series in the LPI database and number of species in each Living Planet Report since 2006. WWF/ZSL (2020)[22].



Taxonomic group	2018		2020		Difference	
	Populations	Species	Populations	Species	Populations	Species
Birds	5,433	1,513	6,666	1,586	23%	5%
Mammals	2,894	597	4,422	658	53%	10%
Fish	7,329	1,501	8,412	1,635	15%	9%
Amphibians and Reptiles	1,048	394	1,311	513	25%	30%
Total	16,704	4,005	20,811	4,392	25%	10%

Table 2:
Changes in the number of populations and species for different taxonomic groups between LPR 2018 and 2020. WWF/ZSL (2020)[22].

A monitor lizard (*Varanus macraei*), Papua New Guinea.

Realm	Class	No. of species known to science	No. of species in LPR 2018	No. of species in LPR 2020	Diff #	% representation LPR 2018	% representation LPR 2020	Difference in representation
Afrotropical	Amphibia	777	4	4	0	1%	1%	0,0%
	Aves	2,294	124	139	15	5%	6%	+ 0,7%
	Fishes	2,875	51	51	0	2%	2%	0,0%
	Mammalia	1,173	127	131	4	11%	11%	+ 0,3%
	Reptilia	1,703	14	16	2	1%	1%	+ 0,1%
Australasia & Oceania	Amphibia	532	15	19	4	3%	4%	+ 0,8%
	Aves	1.927	181	194	13	9%	10%	+ 0,7%
	Fishes	479	13	11	- 2	3%	2%	- 0,4%
	Mammalia	699	29	53	24	4%	8%	+ 3,4%
	Reptilia	271	49	52	3	18%	19%	+ 1,1%
Indo-Malaya	Amphibia	787	11	11	0	1%	1%	0,0%
	Aves	2,017	110	115	5	5%	6%	+ 0,2%
	Fishes	2,103	5	4	- 1	0%	0%	0,0%
	Mammalia	940	78	90	12	8%	10%	+ 1,3%
	Reptilia	1,440	10	13	3	1%	1%	+ 0,2%
Nearctic	Amphibia	267	78	80	2	29%	30%	+ 0,7%
	Aves	725	497	495	- 2	69%	68%	- 0,3%
	Fishes	791	117	128	11	15%	16%	+ 1,4%
	Mammalia	481	110	116	6	23%	24%	+ 1,2%
	Reptilia	472	63	65	2	13%	14%	+ 0,4%
Neotropical	Amphibia	2,322	61	150	89	3%	6%	+ 3,8%
	Aves	3,890	359	363	4	9%	9%	+ 0,1%
	Fishes	4,909	125	134	9	3%	3%	+ 0,2%
	Mammalia	1,282	105	107	2	8%	8%	+ 0,2%
	Reptilia	2,557	39	46	7	2%	2%	+ 0,3%
Palearctic	Amphibia	376	17	25	8	5%	7%	+ 2,1%
	Aves	1,575	361	394	33	23%	25%	+ 2,1%
	Fishes	1,681	54	73	19	3%	4%	+ 1,1%
	Mammalia	906	118	131	13	13%	14%	+ 1,4%
	Reptilia	790	26	27	1	3%	3%	+ 0,1%

Table 3:
Changes in the number of terrestrial and freshwater species for different taxonomic groups within each realm between LPR 2018 and 2020. Note that in some cases there was no change in representation (0%) or the change in presentation was negative, because of taxonomic changes (where multiple species were grouped into one, the total number of species for that group represented in the LPI has decreased). WWF/ZSL (2020)[22].

Where do the data used in the LPI come from?

Across the globe, wild animals are counted for a variety of different reasons. If such monitoring is done over multiple years in a particular area, the change in population sizes can be used to establish whether, on average, the abundance of monitored species has increased, decreased or stayed the same. This abundance change information is taken from the Living Planet database, which comprises time-series of either population size, density, abundance or a proxy of abundance of any vertebrate species in any location. Data can be included only if a measure of population size is available for at least two years, information is available on how the data were collected, what the units of measurement were, and the geographic location of the population. The data must be collected using the same method on the same population throughout the time-series, and the data source must be referenced and traceable. Time-series information for the LPI is currently collated from more than 3,000 individual data sources such as published scientific literature, online databases and grey literature.

While an LPI can be calculated using data from any species, the current approach focuses only on vertebrate species (i.e. birds, mammals, fish, amphibians and reptiles) because these are groups that have been monitored more consistently and for longer.

Are extinct species included in the LPI?

Yes, although there are very few. For example, the golden toad (*Incilius periglenes*) is listed as Extinct on the IUCN Red List of Threatened Species, as extensive searches have not managed to locate any individuals since 1989. In the LPI, the last recorded survey data is included, which documents the decline of this species[34]. If some individuals of a species are alive only in captivity, then the species is assessed as Extinct in the Wild on the Red List. This is the case for the Guam rail (*Hypotaenidia owstoni*), for which there is also data in the LPI. This species declined because of predation from an introduced brown tree-snake on the island of Guam. A captive population of the Guam rail exists in a snake-proof enclosure on the island.

CALCULATING THE LPI

How is the LPI calculated?

The global LPI is calculated based on 20,811 population time-series of 4,392 species which are gathered from a variety of sources. For each population, the rate of change from one year to the next is calculated. If the data available are from only a few, non-consecutive years, a constant annual rate of change in the population is assumed between each data year. Where data are available from many years (consecutive or not) a curve is plotted through the data points using a statistical method called generalized additive modelling. Average annual rates of change in populations of the same species are aggregated to the species level and then higher levels [35]. The higher-level aggregation is based on a weighting system that takes into account species richness to address certain geographic and taxonomic biases in the LPI data set [27]. This weighted approach is described in more detail below.

A deeper dive: A step-by-step guide to calculating an LPI

An LPI is calculated in multiple steps:

- **First, each population's size is modelled over time and the population size in any year compared to the population size in the previous year.** The original abundance values are logged, so that differences between years describe a relative rather than an absolute change. This means that we can combine information from populations with different measures of abundance and different numbers of individuals.
- **In each year, these interannual change values are averaged across all populations of a species to give an overall trend for that species.**

- **The species trends are then averaged to obtain an overall trend.** A type of average known as the geometric mean is used, which has been shown to be particularly suitable for assessing relative change in population sizes [28,36]. In cases where the amount of data is large enough, for example for the global LPI, the averaging process is adjusted to account for the fact that species and monitoring programmes are not evenly distributed across the globe. The LPI method then takes into account how much of the world's vertebrate biodiversity the species in the LPI represent by giving most weight within a biogeographic realm to the most species-rich group [27]. This means that not all of the weight is placed on the groups for which there is more information in the database (although this could be the case in well-monitored areas). For most realms, fish are given the most weight (around a third), followed by reptiles and amphibians (around a third) and birds (around a quarter), and finally mammals (less than a fifth). Each realm is then given a weighting depending on its species richness to give an overall trend for each realm.

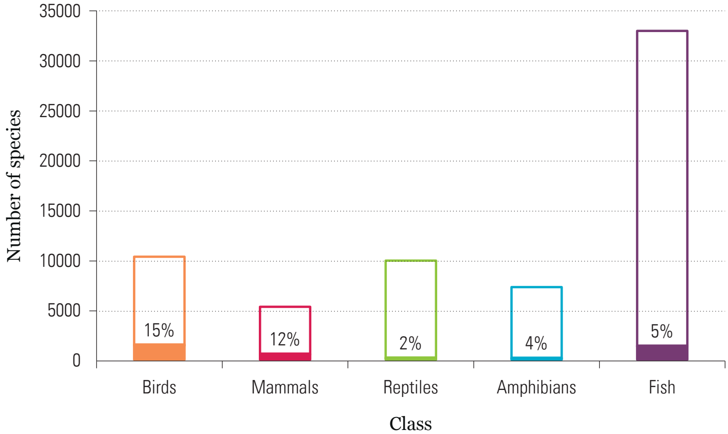
- **The averaging and weighting is done separately for populations occurring in the three systems (terrestrial, freshwater and marine), which are then equally weighted to obtain one set of interannual change values.**

- **These values are then turned into the global index by setting the value to 1 in 1970 and relating each change to this baseline.** Confidence limits are calculated around these values which describe how certain we are about the index value in any given year relative to 1970. The baseline year and the cut-off year are chosen because not enough information is available before 1970 or after 2016 to produce a robust and meaningful index.

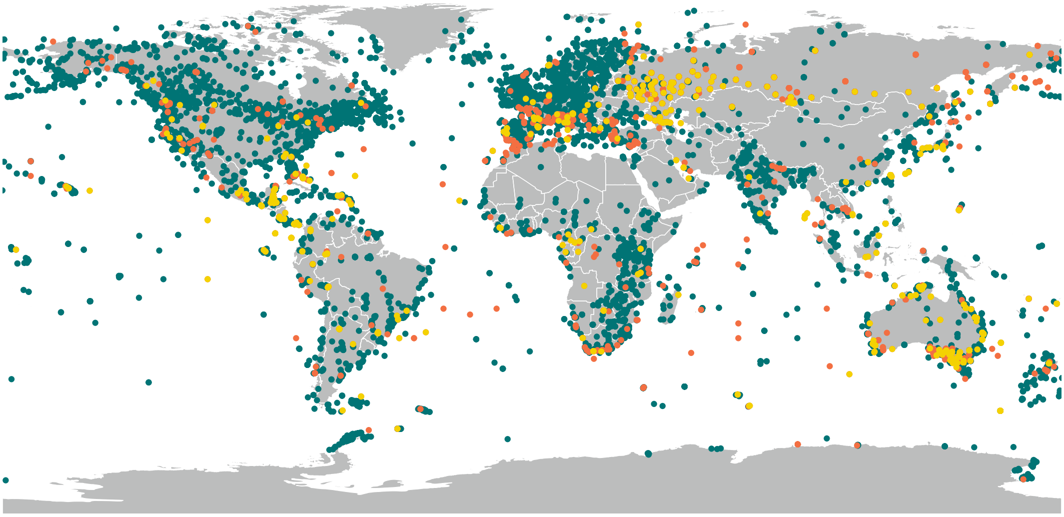
Why does the LPI use a weighted approach?

The LPI contains data for 4,392 out of more than 62,000 vertebrate species that have been described globally (Figure 11). There is no 'perfect' LPI which has data for all species from all over the world. The challenge therefore is to represent all 62,000 described species using those for which data are available. One way to address this problem is to collect more data and improve the taxonomic and geographic coverage of the dataset. This was the approach taken until LPR 2012.

Figure 11:
Number of species represented in the LPI versus number of species known to science in each taxonomic group. WWF/ZSL (2020)[22].



A second approach is to make the indicator more representative of vertebrate biodiversity by accounting for the estimated diversity of species globally. Because the LPI dataset is not uniformly distributed across regions and species (Figure 12), a new approach is being employed to calculate indices that reflect the number and distribution of vertebrate species in the world. The LPI-D method[27] involves a system of weighting that reflects the actual proportions of species found in each taxonomic group and realm. These proportions allow the index to be weighted accordingly and are presented on the next page.



How do the LPI weightings work?

The higher-level aggregation in the LPI is based on a weighting system that takes into account species richness to account for certain geographic and taxonomic biases in the data set [27]. The greater the number of species for a given group within a realm, the more weight given to the population trends of those species. For example, fish species represent the largest proportion of vertebrate species in both freshwater and marine biogeographic realms, so this group is given most weight in the index calculation for these two realms. In the terrestrial realms, reptiles and amphibians are the largest vertebrate group in the tropical realms (Afrotropical, Neotropical, Indo-Pacific), whereas birds are the largest group in the temperate realms (Nearctic, Palearctic).

This diversity-weighted ('LPI-D') method provides a means of reducing bias in groups such as temperate birds, which have previously dominated some of the global and regional LPIs. As an example, there are 442 terrestrial Palearctic species in the LPI, of which 67% are birds, 27% are mammals, and 6% are reptiles and amphibians. The unweighted LPI-U method would have weighted each group in these proportions. The LPI-D method reflects the proportion of species that should be found in each group. This gives 43% of the weight to bird species, 32% to reptiles and amphibians and 25% to mammals. In other words, the LPI-D method gives reptiles and amphibians more weight, and birds and mammals less weight, to better reflect the actual diversity of species.

The global LPI is an average of the terrestrial, freshwater and marine LPIs, giving an equal weight to each.

Figure 12:
Map showing the locations of the populations in the LPI monitored in specific locations. Newly added populations since the last report are highlighted in orange, or in red for species new to the LPI. WWF/ZSL (2020) [22].

Key

- New species
- New populations
- Existing data

How are different LPIs calculated?

System LPIs, such as the Freshwater LPI presented in the report, are calculated by first producing realm indices using the LPI-D method as described above. The system LPIs are then calculated using a weighted average of the realm LPIs for that system. The values for the weighting are equivalent to the proportion of vertebrate species each realm contains compared to the estimated total number of vertebrate species for that system. For example, the Neotropics carry the most weight and the Nearctic the least in the freshwater LPI because more species occur in the former.

The indices for IPBES regions shown in the report are also calculated using a weighted approach, according to the number of species included in each taxonomic group within each region.

Addressing challenges and improving the LPI

In order to continue improving the global representation of the LPI, targeting geographic gaps in the data is an ongoing priority. Part of this process will be accelerated through the use of a recently developed automated tool. This tool is able to detect data sources which are likely to contain population trends, therefore speeding up the process of finding new data.

Machine learning can also help us start to understand how populations might respond to predicted changes in climate and land-use (this is explored more in one of the LPR 2020 'deep dive' reports - Too hot to handle: a deep dive into biodiversity in a warming world). The LPI shows population trends in the recent past, from 1970 to almost the present day. This helps us to understand what has happened and why, but doesn't inform us on how different solutions might benefit wildlife in the future. Moving from explaining recent trends in nature, to predicting what might happen to the LPI under different policies and management strategies, is the next stage in development as we try to bend the curve of biodiversity loss.

Efforts are also underway to incorporate data on invertebrates, starting with insects (Chapter 1). The LPI contains data only for vertebrate species, as these have been better monitored historically. However, as vertebrates only represent 3% of all known species, we know we might not be getting the full picture.

Adding other groups such as insects, targeting data gaps and exploring how the LPI responds under different future scenarios will help us to build a more comprehensive picture of how biodiversity is changing and what actions we can take to bend the curve of biodiversity loss.

Tree frog in the rain,
Manu National Park, Peru.


Image from the Our Planet series, © Paul Stewart / Netflix / Silverback

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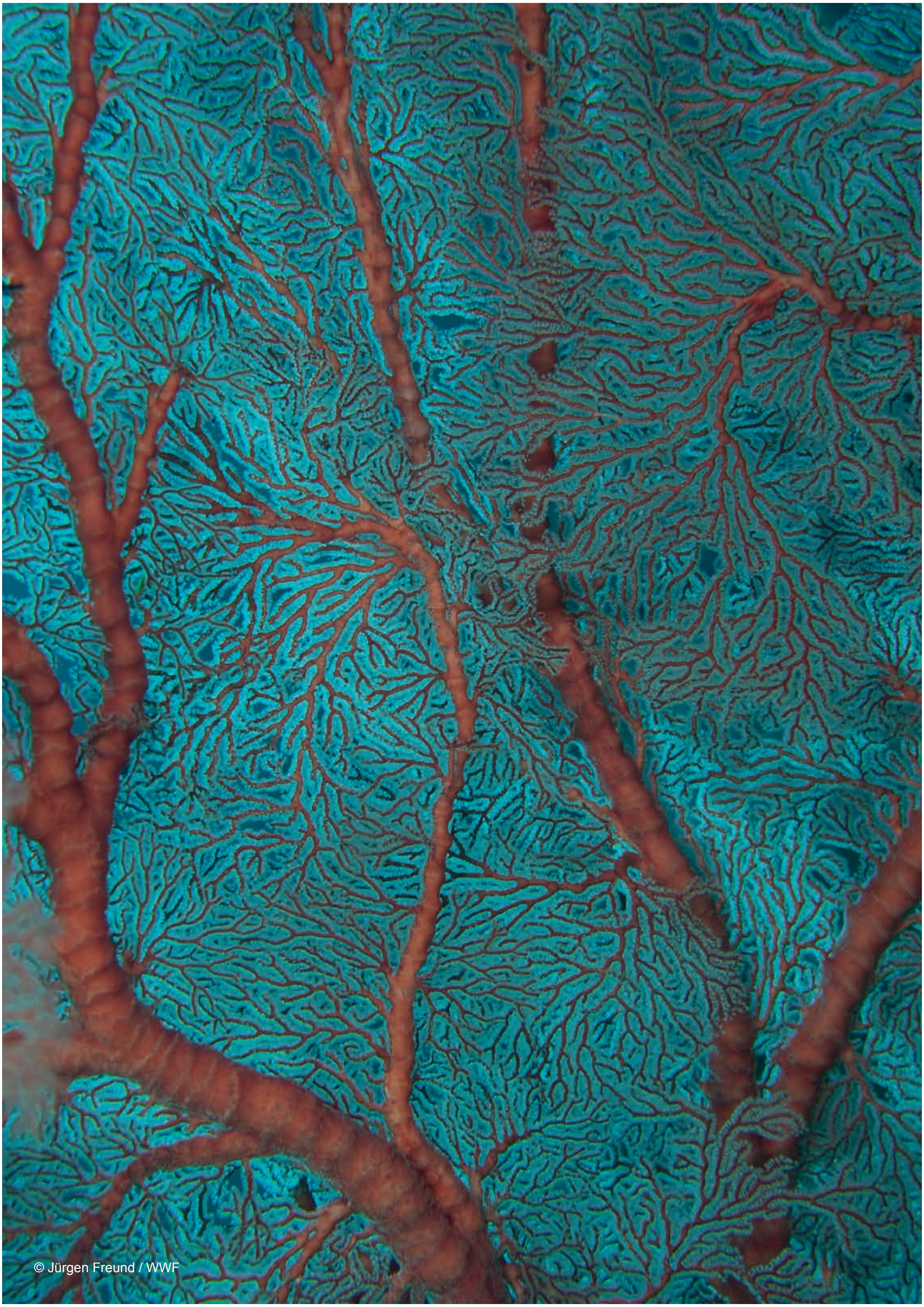
Detail of a fancoral (*Melithaea* sp.) in West Papua, Indonesia.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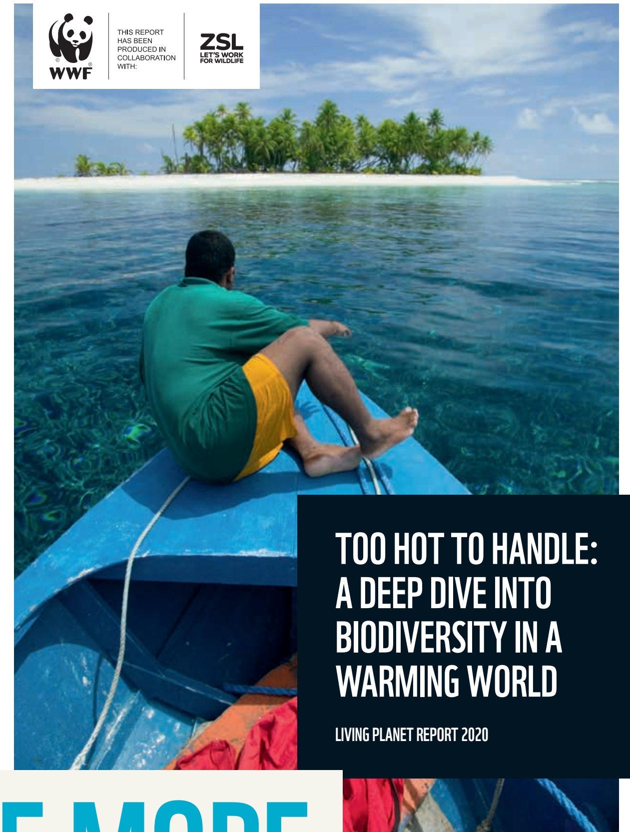

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