

Abstract

The State of Nature Reports

The State of Nature Reports have been published since 2010 by Hamaarag – Israel's National Ecosystem Assessment Program. The reports present ecosystem trends and processes in Israel and provide a glimpse into the state of nature in Israel. The aim of the reports is to provide a scientific basis for developing informed, sustainable management practices for open landscapes and for biodiversity in Israel. The present volume, Biodiversity, follows the previous volume, [The State of Nature Report 2022 – Trends and Threats Volume](#).

'The State of Nature Report 2023 – Biodiversity Volume' is largely based on a ten-year summary of the national terrestrial monitoring program. Within the framework of this program, a monitoring system comprising approximately 900 sampling plots was set up in nine monitoring units that represent various habitats in Israel. The groups sampled in the monitoring units comprised plants, arthropods, reptiles, birds, and mammals, both in close vicinity to settlements or farmlands and more distant from them (different groups were monitored in the different units).

The main monitoring questions addressed the temporal changes in biodiversity during the monitoring period and the effect of human settlements and agriculture on the ecosystems. The data analysis focused mainly on the different diversity indices and on species composition. The report also summarizes findings from additional sources: wildlife counts by the Israel Nature and Parks Authority (INPA), national monitoring programs for streams, the Sea of Galilee, the Mediterranean Sea, and the Red Sea, and the National Butterfly Monitoring Program, which is a citizen-science program. Data collection and processing, presentation of the results and analyses, and a discussion of the findings in this report provide a comprehensive overview of the current state of nature in Israel.

The Main Results

Part A – Biodiversity in Israel – National Update

Vegetation

In Israel there are approximately 2,700 species of native plants, including **405 (15%) endangered species**, of which 64 species are critically endangered. The report's findings are based on both data collected via remote sensing over a period of 38 years and data from ground monitoring that was sampled over a decade within the framework of Hamaarag's monitoring program. **In the Mediterranean region there has been a 36% increase in the average vegetation index (NDVI)**, which represents the density and vitality of the vegetation over the last four decades. This finding points to a process of recovery of the woody vegetation following

long periods of suppression due to pressure from wood-cutting and intensive grazing. However, in the absence of thinning, particularly in the woodlands, overcrowding of trees and climbers is expected to lead to reduced biodiversity. During this period no significant change was found in the vegetation index in the desert region. **In Israel, 61 invasive plant species have become established**, and 127 additional alien plants were found in natural landscapes, of which 12 have a high potential to become invasive. The main factors threatening plants in Israel are habitat loss and fragmentation, edge effects (particularly from agricultural sources), invasive

species, and climate change. The spread of native vegetation and invasive plant species has led to the loss of most of the sandy habitat that previously characterized the dunes of the coastal plain, such that **less than 4% (5.2 km²) of the remaining natural landscape still comprises active dunes devoid of vegetation** – a habitat for many unique species.

Butterflies

In Israel there are 133 species of butterflies, including **51 (38%) endangered species**, of which 11 species are critically endangered. The report's findings are based on data collected over a 13-year period within the framework of the National Butterfly Monitoring Program in Israel, which is operated by a community of volunteers. During the monitoring period **a 34% decrease was found in the abundance of butterflies, as well as a change in seasonality – a 30-day delay in the peak of butterfly abundance**. The sharp decline in butterfly abundance probably reflects a decrease in the abundance of all insects in Israel, as also observed for extensive areas throughout the world. A delay in peak abundance reflects an extreme change in the phenology (cyclicality) of the butterflies, and probably stems from climate change, which both directly (via environmental temperature) and indirectly (via the state of the vegetation) disrupts the life cycles of some butterfly species. **In Israel, four invasive butterfly species have become established**. The main factors threatening butterflies in Israel are agricultural pest control and other edge effects, habitat loss and climate change.

Reptiles

In Israel there are 88 species of reptiles. Currently, a new assessment of extinction threats to all reptile species in Israel is being conducted. The report's findings are based on data collected over a seven-year period within the framework of Hamaarag's monitoring program, and counts of turtle nests conducted by the INPA. **There has been a 58% decline in the abundance of reptiles in the' Western**

Negev dunes 'unit and a 48% decline in the abundance of reptiles in the' Northern Negev Loess Plains 'unit. The declines in abundance in these two desert units may stem from the warming and drying trend that has been taking place over many years. No significant change in abundance was found in the other monitoring units. In recent decades **there has been an increase in the number of green sea turtle and brown sea turtle nests**, which are assessed by counts on the beaches, and the efforts to protect and reintroduce sea turtles appear to be bearing fruit. **In Israel, four invasive reptile species have become established**. The main factors threatening reptiles in Israel are habitat loss and edge effects, including invasive and locally overabundant species.

Birds

In Israel there are 226 breeding bird species (out of 550 species), including **65 (29%) endangered species**, of which 21 species are critically endangered. The report's findings are based on data collected over a nine-year period within Hamaarag's monitoring program along with counts conducted by the Israel Nature and Parks Authority. During the monitoring period there was **a 17% decline in total abundance of common breeding birds in Israel, a four-fold faster rate than that in Europe**. Most of the groups that exhibited a decline were human companion species and species typical of the batha. **Four human companion species declined in abundance: common yarrow, common blackbird, European turtle dove, and laughing dove; the abundance of an invasive species, the common myna, increased by 585%**. Various studies have indicated that predation and competitive displacement of bird species by the myna, and its trend of spreading beyond human settlements into open landscapes, pose an increasing threat to other species. The INPA counts reported **a decline in the number of nest initiations by the Eurasian griffon vulture** over a 21-year period. On the scale of the monitoring units there was **a decline in the abundance of additional species: the graceful prinia, crested lark, house sparrow and Eurasian collared dove**. The edge effects of human settlements and

agriculture leak into the natural landscapes and have a negative impact on many bird species. **In Israel, nine invasive bird species established**, and five additional alien species are currently in the establishment stages. The main factors threatening birds in Israel are habitat loss, the spread of invasive species, collision with power lines, electrocution, and poisoning.

Mammals

In Israel there are 97 species of mammals, including **61 endangered species (62%)**. The report's findings are based on data collected over a 10-year period within the framework of Hamaarag's monitoring program, along with counts conducted by the INPA. Of all the species observed during the monitoring program, analyses were conducted on ten medium-sized and large-sized mammalian species, of which the abundance of six species was found to be increasing: the cape hare (on the national scale), Indian crested porcupine (in the Mediterranean monitoring unit), and grey wolf, golden jackal, red fox, and Dorcas gazelle (in the desert monitoring units). **Most of the mammals that are increasing in numbers are human companion species**, which exploit the availability of human-based resources such as water, food and shelter. Populations of these mammals thrive as resource availability increases. **The increase in abundance of canine species in the desert region** stems from the increase in food availability deriving from agricultural waste, and is affected by the competitive displacement dynamics among these species: in regions with an increased presence of wolves – there are fewer jackals, and in those with an increased presence of jackals – foxes are excluded. The count data indicate that over the last 20 years there has been **a trend of increasing abundance of the following ungulates: Palestine mountain gazelle, Dorcas gazelle, acacia gazelle, and Nubian ibex**. This joint trend stems from significant efforts to protect these species and their habitats, particularly the acacia gazelle, which was on the brink of extinction. In contrast, presence-absence surveys have indicated **a reduction in the distribution**

range of the otter in Israel a 20-year period. **There are two known invasive mammal species in Israel**. The main factors threatening mammals in Israel are habitat loss and fragmentation and road kill.

Part B – The State of Biodiversity in the Terrestrial Monitoring Units

Mediterranean woodland

- A 38% increase in the vegetation index (NDVI) in the wet woodland areas and a 25% increase in the dry woodland areas over the last four decades (1984–2022)
- A 461% increase in the abundance of the chukar over a 9-year period (2012–2021)
- Decreases of 74% and 54% in the abundance of the European turtle dove and graceful prinia, human companion species, over a 9-year period (2012–2021)

Planted pine forests

- A 38% increase in the vegetation index (NDVI) over the last four decades (1984–2022)
- A 90% decrease in the abundance of the European turtle dove over a 7-year period (2014–2021)
- A decrease in the abundance of the golden jackal, a locally overabundant species, in the Mt. Carmel forests, over an 8-year period (2013–2021)
- An increase in the abundance of wild boar in the Judean Hills over an 8-year period (2013–2021)

Semi-steppe batha and herbaceous batha

- A 34% increase in the vegetation index (NDVI) over the last four decades (1984–2022)
- A 44% decrease in the abundance of breeding birds over a 6-year period (2014–2020)
- A decrease in the abundance of birds typical of the batha, on average, over a 6-year period (2014–2020)
- An increase in the abundance of the red fox, a locally overabundant species, over an 8-year period (2014–2022)

Coastal sand dunes

- Less than 4% of the current native area of the coastal sand dunes remains as active sand dunes devoid of vegetation (exposed sand) (5.2 km²)
- A 68% increase in the vegetation index (NDVI) over the last four decades (1984–2022)
- The composition of arthropods in the northern part of the coastal sand dunes differs from the composition in the southern part
- The total abundance of reptiles is 19% lower in the vicinity of human settlements compared to their abundance in areas that are distanced from human settlements

Desert transition zone

- A decrease in the abundance of endangered birds and birds typical of the batha over an 8-year period (2012–2020)
- A 1,020% increase in the abundance of the common myna, an invasive species, over an 8-year period (2012–2020)
- A 97% decrease in the abundance of the house sparrow, a human companion species, over an 8-year period (2012–2020)
- An increase in the abundance of the Palestine mountain gazelle over an 8-year period (2014–2022)

The loess plains of the northern Negev

- Species of birds typical of the batha and that are also considered endangered were observed almost entirely only in the natural loess landscapes
- A 106% increase in the abundance of the common myna, an invasive species, over an 8-year period (2012–2020)
- A 70% decrease in the abundance of the Eurasian collared dove over an 8-year period (2012–2020)
- A 48% decrease in the abundance of reptiles over a 6-year period (2014–2020)

Western Negev dunes

- The vegetation index (NDVI) has not changed over the last four decades (1984–2022)
- The composition of arthropods differs between active dunes, semi-stable dunes, and areas near agricultural crops in net houses

- The species richness of birds near agriculture is higher than their richness in areas that are distant from agriculture, and is characterized by a presence of human companion species
- In each 2 km of nature reserve there are approximately 33 km of dirt tracks

The Negev Highlands

- Birds of human companion species are active in river channels that are distant from human settlements
- An increase in the abundance of the Dorcas gazelle and the striped hyena over eight years (2014–2022)
- An increase in the abundance of the Indian crested porcupine over an 8-year period (2014–2022)
- A marked increase in the abundance of the golden jackal, a locally overabundant species, in the vicinity of human settlements, over an 8-year period (2014–2022)

The arid south

- A 101% increase in the abundance of all birds in areas that are far from plantations and orchards over an 8-year period (2012–2022)
- An increase in the abundance of human companion bird species over an 8-year period (2012–2020)
- A 78% decrease in the abundance of the European turtle dove over an 8-year period (2012–2020)
- An increase in the abundance of the grey wolf over an 8-year period (2014–2022)

Part C – State of Biodiversity in the Aquatic Monitoring Programs

Streams

This chapter is based on the monitoring program of the Israel Center for Aquatic Ecology (CAE), the Steinhart Museum of Natural History, Tel Aviv University. The state of biodiversity of most of Israel's streams is poor due to a combination of factors, including flow of wastewater and sewage into streams, human exploitation of natural water sources, artificial regularization of riverbanks, establishment of dams and conduits, agriculture adjacent to riverbanks and the spread of invasive species. The streams of the Kishon and Yarkon basins are characterized by a particularly high richness and abundance of alien species, some of which are feral species from aquaria, while others have invaded from the stream flows. Following restoration efforts in recent years, there has been a certain improvement in biodiversity indices in a number of streams on the coastal plain. The state of biodiversity in the streams of the Sea of Galilee basin is good in comparison to all the other perennial streams.

The Sea of Galilee

This chapter is based on the findings of the Sea of Galilee monitoring program, led by the Kinneret Limnological Laboratory, Israel Oceanographic and Limnological Research (IOLR). Climate change, which is expressed in a decrease in the amount of precipitation and an increase in extreme drought and flood events, has led to increased pumping of water from streams and the groundwater, and contributes to a trend of declining volumes of available water in the lake, an increase in the fluctuation range of the sea level and an increase in the average temperature of the water. These changes have had a negative impact on biodiversity in the lake. The extreme fluctuations in sea level have led to **an extreme reduction in the abundance of local mollusks and domination of the invasive snail, *Thiara scabra***, which comprises ca. 95% of all snails in the lake. Moreover,

the three local species of oysters in the Sea of Galilee are now endangered following the changes in sea level. In the past, the alga *Peridinium* was responsible for approximately half of the organic carbon sequestration in the lake. This alga serves as food for fish and acts as an indicator of the stability of the system. Its concentration is now decreasing and there is a concern that it is on the brink of extinction from the algal community.

The Mediterranean Sea

This chapter is based on the findings of the national program for monitoring the Mediterranean Sea, conducted by the IOLR. **Climate change is causing a rise in water temperature** of 0.13°C per year on average in the open sea, and a rise of ca. 0.07°C adjacent to the coast; **a rise in sea level of 4.6 mm per year on average (30-year average); and a rise in salinity and acidity levels of the water.** These changes are faster than the rate of change in other locations both around the Mediterranean Sea and around the world in general. **To date, 445 alien species have been documented on Israel's beaches,** including invasive species, leading to reductions in the populations of local species, often to the point of local extinction. **Approximately one-third of the commercial fish in Haifa Bay have been found to be polluted by mercury. Most of the coastal river flows are polluted by fertilizers.** Only ca. 4% of Israel's territorial water surface is protected in nature reserves.

The Red Sea – Gulf of Eilat

This chapter is based on the findings of the national monitoring plan for the Gulf of Eilat, conducted by the Interuniversity Institute for Marine Science in Eilat.

In the last two decades biodiversity on both the reef and the seabed has recovered significantly. However, there has been a 93% decline in the size of the sea urchin population, which plays an important role

in controlling the abundance of algae on the reef. **Climate change has been expressed by a 1.15°C increase in average annual temperature of the sea surface over the last 35 years. Moreover, there has been an increase in the frequency of extreme climate events,** such as the high water temperatures measured in 2017 and the unusually strong storm that occurred in 2020. Extensive development plans (including development of beaches near the coral reef), increased conveyance of crude oil, light pollution, and an abundance of divers may be hampering the ability of the ecosystem to recover after extreme events, leading to renewed biodiversity deterioration.

Summary

A decrease in the abundance of many species in Israel: The decline in birds and butterflies reflects the broader picture of deteriorating biodiversity in Israel over the last decade. This trend joins the decline in abundance detected in these two groups in other regions around the world, although the rate of decline in Israel, as noted in this report, is significantly higher. The decline in abundance is caused by the combined effects of environmental changes that directly and indirectly impact these two groups. Furthermore, the state of each of these groups affects both the state of the other group and the entire terrestrial ecosystem.

Threats to nature in Israel: The threats to biodiversity in Israel are essentially no different to those in most countries around the world; however, the intensity and rate of their effects is usually higher. The high human population density and growth rate, along with the characteristics of development, the small dimensions of the country, and planning priorities, have generated massive environmental pressures on biodiversity. Moreover, Israel's location in the Eastern Mediterranean Basin, a region strongly affected by climate change, adds a broad-scale threat that weakens the ecosystem (Figure 1).

Edge effects: Human settlements and agriculture were found to be a major threat to biodiversity in Israel, particularly in the Mediterranean region. The impact is caused directly, through habitat loss when converting natural landscapes and indirectly, as a source of extensive edge effects that impact and weaken biodiversity in the natural landscapes adjacent to human settlements and farmlands. These edge effects include leakage of pollutants (herbicides, sewage and waste, light, and noise) and the spread of locally overabundant and invasive species from human settlements and farmlands into the natural landscapes. Human companion species, including locally overabundant and invasive species, thrive due to the abundant resources provided by human settlements and farmlands, and alter the species composition in the natural landscape via predation and competition. The resulting significance lies in that, in practice, the negative impact zone of farmlands and human settlements on biodiversity in Israel greatly exceeds their boundaries, and they have a significant impact on the functioning of ecological corridors (Figure 2).

Monitoring and managing biodiversity: The findings arising from the ecosystem monitoring are intended for use by field managers, planners, and decision-makers to help them formulate policy and management practices for informed, sustainable management of ecosystems in Israel. Efforts to protect, restore, and reintroduce species have led to significant success in the preservation of flourishing ungulate populations in Israel. Management of protected landscapes in nature reserves and forests, maintenance of ecological corridors and implementation of local management practices such as sanitation, reduce the negative effects of development on natural ecosystems and contribute to biodiversity conservation. These efforts, however, are countered by the expansion of human settlements, agriculture, and infrastructure, accompanied by the spread of invasive species into natural landscapes on the one hand, and the spread of certain wild species into developed human environments on

the other hand. Long-term monitoring is critical for understanding the implications of anthropogenic development and the outcomes of efforts to protect nature in Israel.

Future plans: This is the 11th year of Hamaarag's national terrestrial monitoring program. In the coming year we will conduct a comprehensive assessment of the monitoring program in light of the summary of the first ten years, and with the help of our partners and scientific advisors, we will construct plans for the next decade of the monitoring program. We will implement adjustments and necessary changes in the monitoring system to ensure the continued monitoring of the main processes affecting nature and to assess the response of biodiversity to these processes through systematic collection of ecological data over time. Technological innovations now enable more effective and accurate monitoring methods. One of the main challenges in updating the monitoring program will therefore be to assimilate these new technologies while also maintaining continuity with the information collected over the past decade. The update of the monitoring program will preserve its main aim: to provide long-term, extensive, reliable, relevant information on the state of nature in Israel.