STUDY ON THE LINKAGES BETWEEN PROTECTED AREAS AND THE CONSERVATION OF BIODIVERSITY FOR FOOD AND AGRICULTURE
Thematic Study for *The State of the World’s Biodiversity for Food and Agriculture*
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Thematic Study for *The State of the World’s Biodiversity for Food and Agriculture*

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Executive summary

Protected areas cover substantial proportions of the world’s land and marine areas, where they contribute to the conservation of biodiversity and the delivery of ecosystem services. Yet little is known about the role of protected and conserved areas in the conservation of biodiversity for food and agriculture. This study seeks to assess current knowledge and knowledge gaps.

The study includes a detailed global gap analysis of the coverage of biodiversity that is classified as used for food by humans in The IUCN Red List of Threatened Species™ (The IUCN Red List) by the protected area network. Up-to-date information on protected areas is taken from the World Database on Protected Areas (UNEP-WCMC and IUCN, 2018a).

The study finds that protected areas cover 14.8 percent of the world’s terrestrial areas, and 7.44 percent of marine areas (data correct November 2018, UNEP-WCMC and IUCN, 2018a). The role of protected areas in the achievement of national and global biodiversity goals and targets (such as the Sustainable Development Goals and the Aichi Biodiversity Targets) is well established. Efforts are under way to understand, improve and describe the impact and effectiveness of protected areas in relation to the conservation of biodiversity and delivery of ecosystem services.

The IUCN Red List contains assessments of 87,967 species, of which 11 percent are classified as used for food by humans (IUCN, 2017). Of those species known to be used for food, 18 percent are categorized as species threatened with extinction.

The gap analysis undertaken in this study included 4,243 species – those that are classified as used for human food in The IUCN Red List and for which sufficient data are available to allow them to be mapped in relation to protected areas. The analysis showed that 63 percent of species analysed were “covered” by protected areas (i.e. the species’ geographic ranges completely overlapped with protected areas or they met their conservation target), while 2 percent were “gap” species (i.e. they were not covered by protected areas) and 35 percent were partially covered (i.e. they partially met their conservation target). Twenty-seven percent of the species analysed were classed as threatened with extinction. Among threatened species, over half were found to be partial gap and gap species. These results are comparable to those of similar global gap analysis of coverage of species’ ranges by protected areas, as threatened species tend to have smaller range sizes that fall outside the protected area network.

This study does not provide any insights into the effectiveness of protected areas in conserving species used for human food. However, analysis of a survey of managers of protected area sites considered to be “effectively” managed showed that they perceived that protected areas contribute to the protection and delivery of ecosystem services such as pollination and water provision to food and agricultural systems.

The study is therefore an initial analysis of the contribution of protected areas to the conservation of biodiversity for food and agriculture and particularly of wild species used for food. Additional analyses conducted at intervals would allow better understanding of how effectively protected areas conserve biodiversity for food and agriculture over time.
1. Introduction

Protected areas cover substantial proportions of the world’s land and marine area (see below for more details) and are considered the single most effective way to conserve biodiversity in situ (Margules and Pressey, 2000; Barnes et al., 2016). The objective of this study is to assess current knowledge and knowledge gaps with regard to the linkages between protected areas and biodiversity for food and agriculture (BFA).

At the global level, it has not yet been possible to make direct analyses of the state of conservation of biodiversity, including BFA, through systems of protected and conserved areas. Some analysis of conservation of plant diversity and threatened plant species is undertaken at national level, notably in South Africa. Various analyses have estimated the extent to which protected areas overlap with the range of threatened bird species. In Africa, for example, a study found that 37 out of 144 globally threatened species had no suitable habitat within protected areas, and a further 85 had less than 25 percent of their extent of suitable habitat within protected areas (Beresford et al., 2011). The role of protected areas in the global conservation of migratory birds is discussed by Runge et al. (2015).

However, little is known about the role of protected and conserved areas specifically in the conservation of BFA. In addition, knowledge about the effectiveness of protected areas in relation to biodiversity outcomes is limited, although much work is currently under way to reduce that knowledge gap (see Box 2). Previous research has indicated that protected areas may be relatively inefficient in terms of covering global biodiversity (Butchart et al., 2015).

Clearly, protected areas are not the only means by which BFA can be conserved. Ex situ conservation, for example, is a useful approach. However, ex situ conservation activities are not without drawbacks and difficult to implement for some components of BFA (e.g. Cock et al., 2011; FAO, 2014a; 2015; 2019a).

This study includes an analysis of the extent to which species classified as food in The IUCN Red List of Threatened Species™ (The IUCN Red List), including those classified as threatened at the global scale, are covered by the global protected area network (at the time of the analysis), using data from the World Database on Protected Areas (UNEP-WCMC and IUCN, 2018a). However, while it can be inferred that species that are covered by systems of protected areas are to some extent being conserved by them, a one-off study can provide little information on how trends in the extinction risk of these species are being affected by this coverage and hence on the effectiveness of protected areas in conserving them.

As very little is known at present about conserved areas (sites defined as Other Effective Area-Based Conservation Measures, OECMs) (see Section III), they are not included in the analysis presented in this study. The scope is thus confined to formal protected areas (see Section II).

This includes:

• International protected areas (according to the World Database on Protected Areas (WDPA), these include sites designated under the Man and the Biosphere Programme, Globally Important Agricultural Heritage Systems, sites designated under the Satoyama Initiative, Ramsar Sites and regional protected area programmes and networks such as Natura 2000).

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1 South Africa currently has 2,576 nationally threatened plant species, many of which are endemic to the country. Since 2005, the South African National Biodiversity Institute Threatened Species Programme has collected distribution data for threatened plant species from national and provincial conservation authorities, regional herbaria, and atlas and citizen science programmes (von Staden and Raimondo, undated). Spatial data are now available for 2,345 of the country’s 2,576 nationally threatened plant species. Of these, 1,554 (66 percent) have at least one record within a formally protected area (ibid.). For more information, see http://biodiversityadvisor.sanbi.org/planning-and-assessment/plant-conservation-strategy/target-7/

2 These examples of taxonomic studies are not fully comprehensive; other studies exist.

3 https://www.protectedplanet.net/c/wdpa-lookup-tables
Both terrestrial ecosystems (including water bodies) and marine ecosystems. Species data, including extinction risk data, are taken from The IUCN Red List. Further analysis, when the extent of the OECMs network is better known, may help to improve understanding of the network of both protected and conserved areas in relation to the conservation of BFA.

The analysis does not cover sites defined as Key Biodiversity Areas (KBAs) (see Box 1), except for those that are protected areas.

BFA is defined here as follows: the components of biological diversity of direct relevance to food supply and agriculture together with the components of biological diversity that support agricultural production. This is consistent with the definition used in The State of the World’s Biodiversity for Food and Agriculture (FAO, 2019b), which reads as follows: “the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the ecosystem structures, functions and processes in and around production systems, and that provide food and non-food agricultural products.” It includes the domesticated plants and animals raised in crop, livestock, forest and aquaculture systems, harvested forest and aquatic species, other wild species harvested for food and other products, and what is known as “associated biodiversity”, the vast range of organisms that live in and around food and agricultural production systems, and contribute to their output, such as pollinators, soil micro-organisms and invertebrates that keep soils fertile, and natural enemies of pests. It encompasses terrestrial and aquatic ecosystems of importance to food and agriculture, such as wetlands, mangroves, forests and rangelands.

The present study focuses on wild species used as human food.

The following sections of this report provide: an overview of protected and conserved areas including of their roles and of the various types of protected areas (Section III); a summary of the status and trends of protected areas (data correct at time of the analysis).

**BOX 1. Key Biodiversity Areas**

Key Biodiversity Areas (KBAs) are sites that are defined as “a geographical area on land and/or in water with defined ecological, physical, administrative or management boundaries that is actually or potentially manageable as a single unit (e.g. a protected area or other managed conservation unit)” (IUCN, 2016).

The Global Standard for the Identification of Key Biodiversity Areas (IUCN 2016) helps to identify sites based on risks to species, levels of endemism and other relevant factors. Sites qualify as global KBAs if they meet one or more of 11 criteria, clustered into five categories: threatened biodiversity; geographically restricted biodiversity; ecological integrity; biological processes; and irreplaceability. These criteria can be applied to species and ecosystems in terrestrial, inland-water and marine environments. However, not all KBA criteria may be relevant to all elements of biodiversity, although the thresholds associated with each criterion were designed to be applied across all taxonomic groups (other than micro-organisms) and ecosystems.

The KBA Standard and its defined criteria build on more than 30 years of experience in identifying important sites for different taxonomic, ecological and thematic subsets of biodiversity, and aims to encompass some of the existing approaches to the identification of areas that are important for biodiversity. Such approaches include BirdLife International’s Important Bird and Biodiversity Areas (IBAs), Alliance for Zero Extinction (AZE) sites, KBAs identified by the IUCN Freshwater Biodiversity Unit, the Critical Ecosystem Partnership Fund (CEPF) sites and many others, including approaches for plants such as PlantLife International’s Important Plant Areas (IPAs).

As the definition implies, KBAs are not necessarily conserved through systems of protected areas.
(Section IV); a detailed analysis of the conservation status of wild species used for human food in protected areas and a gap analysis of the coverage of such species in the protected areas network (Section V); a summary of a survey undertaken with selected protected area managers to identify their perceptions of BFA within site boundaries and how they manage these resources (Section VI); and finally some concluding remarks and recommendations.
2. Protected and conserved areas

A protected area is a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (IUCN, 2008).

Protected areas can be managed in a wide variety of ways and under a range of governance types, ranging from strictly protected sites entirely set aside from human intervention to protected landscapes that include long-term managed areas and settled human communities, reserves owned and run by governments and self-declared protected areas run by indigenous communities within their traditional territories (Davies et al., 2012). IUCN classifies protected areas into six management categories (one with a subdivision) according to their management objectives (Table 1). The categories are recognized by international bodies such as the United Nations and by many national governments as the global standard for defining and recording protected areas, and as such are increasingly being incorporated into government legislation.

Designation of protected areas is recognized as an important component of global efforts to improve the in situ conservation of biodiversity. Aichi Biodiversity Target 11, under the Convention on Biological Diversity Strategic Plan for Biodiversity 2011–2020, reads as follows:

*By 2020, at least 17 percent of terrestrial and inland water, and 10 percent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes* (CBD, 2010a).

As noted in the introduction to this study, the analysis presented here does not cover areas defined as OECMs, which are referred to in the text of Aichi Biodiversity Target 11. According to the definition agreed upon by the Conference of the Parties to the Convention on Biological Diversity (CBD) at its fourteenth meeting, an OECM is “a geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in situ conservation of biodiversity, with associated ecosystem functions and services and, where applicable, cultural, spiritual, socioeconomic, and other locally relevant values.”

This definition and the associated guidelines that help to define OECMs mark an important step forward in the way that spatial biodiversity conservation is reported by governments and other stakeholders. Such areas include sites managed by Indigenous Peoples and Local Communities (IPLCs), and Privately Conserved Areas, where conservation is de facto occurring. Defining these areas as conservation areas allows the contributions of site-based conservation to the achievement of global goals such as Aichi Biodiversity Target 11 and relevant Sustainable Development Goals to be taken into account.

OECMs may make a significant contribution to the conservation of BFA. Improvements to the OECM dataset over time will undoubtably enable further analysis of the conservation of BFA through spatial conservation activities.

Protected areas and the provision of ecosystems services related to biodiversity for food and agriculture

The role of protected areas in climate change adaptation and mitigation is well documented. Protected areas contribute to the delivery of a range of other essential ecosystem services of importance to food and agriculture, including by protecting and enhancing water flows and water quality, conserving habitats that maintain nursery, feeding and breeding areas for fish and other species on which people depend, forming soils and maintaining soil
fertility, reducing land degradation, providing havens for pollinators, reducing pollution, maintaining coastal protection and natural flood-control mechanisms and protecting reservoirs of crop wild relatives that can be used to enhance crop productivity and resilience (World Bank, 2010; FAO, 2014b).
While there are different perceptions about the impact of protected areas on the delivery of ecosystem services (notably between site managers and scientists) (Hummel et al., 2017), studies on the provision of ecosystem services through protected areas are wide ranging. Protected area practitioners have noted the role of protected areas in the provision of ecosystem services (Neugarten et al., 2018). For example, studies have focused on the role of ecosystems in relation to carbon stocks and water provision (e.g. Lecina-Diaz et al., 2019). Notably, in sites across Europe (Natura sites), the delivery of ecosystem services is included as a key deliverable related to their implementation and management (European Commission, 2013). Brander et al. (2015) estimated the total ecosystem service economic benefits of achieving 10 percent coverage of marine protected areas to be USD 622–923 billion over the period 2015 to 2050. Mountain protected areas contribute significantly to important ecosystem services such as the supply of clean water, disaster risk reduction and the maintenance of biodiversity (FAO, 2014b).

Protected areas contribute in many ways to the achievement of the Sustainable Development Goals (Dudley et al., 2017). One target under Sustainable Development Goal 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) and two targets under Sustainable Development Goal 15 (Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss) are directly related to protected areas.

Ecosystem services and the conservation of biodiversity (including BFA), are interlinked. Some examples of water-related ecosystem services with linkages to biodiversity for food and agriculture that are provided by protected areas are described by IUCN (undated). The provision or maintenance of water systems is particularly significant in the context of food and agriculture, as “agriculture accounts for approximately 70 percent of all water use globally, and physical water scarcity is already a problem for more than 1.6 billion people” (FAO, 2011). However, few conclusions can be drawn about the relationship between the provision of ecosystem services and direct, measurable changes in the status and trends of BFA or of conservation measures.

The effectiveness of protected areas in the delivery of ecosystem services depends on how effectively sites are managed, how they are integrated with surrounding landscapes and land-use strategies, and whether they are supported by local communities. As protected areas exist under a variety of management and governance regimes, ranging from strict no-access areas to areas with managed harvesting, protected landscapes and indigenous reserves that include human settlements and cultural management (Lopoukhine et al., 2012), the effectiveness of delivery varies across sites.

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*Indicator 14.5.1 is “Coverage of protected areas in relation to marine areas is measured.” Indicator 15.1.2 is “Proportion of important sites for terrestrial and freshwater biodiversity that are covered by protected areas, by ecosystem type.” Indicator 15.4.1 is “Coverage by protected areas of important sites for mountain biodiversity.”*
3. Status and trends of protected areas

Approximately 15 percent of land and inland waters, 10 percent of coastal and marine areas within national jurisdictions, and just over 4 percent of the world’s oceans lie within protected areas (UNEP-WCMC and IUCN, 2018a). The Protected Planet Report 2018 (UNEP-WCMC, IUCN and NGS, 2018) (which is based on the data contained in the World Database on Protected Areas, the most comprehensive source of information about protected areas) anticipates that the coverage element of Aichi Target 11 (see above) on conserving 17 percent of terrestrial areas by 2020 is likely to be met globally (Figure 1).

However, protected area networks remain ecologically unrepresentative. For example, although approximately 9 percent of drylands are under formal protection, these protected areas are not representative of all dryland subtypes. Deserts are disproportionately represented, while temperate grasslands have among the lowest level of protection of all biomes at 4 to 5 percent. To some extent, this is because areas with the lowest economic value were traditionally those designated as protected areas (Gudka et al., 2014). However, it may be worth noting that large areas of drylands are protected by local communities, either consciously (for example as sacred sites) or as a by-product of traditional sustainable management practices (for example as seasonal grazing reserves). Such activities may in the future be captured by efforts to map and manage information about sites categorized as OECMs (see Section III), and our understanding of the conservation of drylands (and the representativeness of protected and conserved areas in general) may improve.

Global protected areas are also considered to be poorly connected, and many sites that are critical for biodiversity are poorly conserved. The element of Aichi Target 11 on protecting 10 percent of coastal and marine areas is on course to be met in coastal waters, although open-ocean and deep-sea areas, including the high seas, are not well covered (Figure 2). The CBD reports that inadequate management, monitoring and enforcement of protected areas remains widespread (CBD, 2014), and this can limit the effectiveness of protected area networks (Watson et al., 2014). There is growing awareness of the particular need for

Figure 1: Progress of global coverage of protected areas

![Progress to date in coverage of protected areas](image)

Note: Figure is based on data published in November 2018.
Source: UNEP-WCMC and IUCN (2018b).
sustainable management of marine ecosystems, but restrictions on use remain controversial. A relatively small proportion of global marine protected areas consists of no-take areas that prohibit extractive practices such as fishing and mining (Thomas et al., 2014). The precise extent of such problems remains unclear, as information on the effectiveness of protected area management in many countries, and on trends in this regard, is limited (Geldmann et al., 2015), although reporting is improving.

To address knowledge gaps on the effectiveness of protected areas, Parties to the CBD were invited, in 2010, to implement management effectiveness evaluations in at least 60 percent of their total protected areas by 2015 (CBD, 2010b). In 2016, all National Focal Points to the CBD were invited to review and update their management-effectiveness data in the Global Database on Protected Areas Management Effectiveness (GD-PAME), which is the most comprehensive global dataset on such assessments, providing information on 238,563 protected areas, covering more than 46 million km², in 244 countries and territories (UNEP-WCMC, 2018). The latest report from the GD-PAME indicates that only 20 percent of national governments provided updated information on management effectiveness (ibid.). However, it is widely recognized that many more assessments have been made than have been formally reported. For example, analyses of national commitments for improving the management effectiveness of protected areas were informally submitted to the CBD Secretariat by 95 countries in 2018. Such commitments included 240 priority actions addressing protected-area management. This indicates significant improvements in the reporting, and in the effectiveness, of protected-area management.

In order to address gaps in reporting and in the implementation of effective management in protected areas and sites that are defined as OECMs, IUCN has adopted a new standard for the IUCN Green List of Protected and Conserved Areas (IUCN and WCPA, 2017) (Box 2). In addition, the IUCN World Commission on Protected Areas (IUCN and WCPA) has developed guidance for conservation in marine protected areas (IUCN and WCPA, 2018).
BOX 2. The IUCN Green List of Protected and Conserved Areas

The IUCN Green List of Protected and Conserved Areas aims to increase the number of protected and conserved areas that deliver successful conservation outcomes through effective and equitable governance and management.

The IUCN Green List of Protected and Conserved Areas Global Standard (IUCN Green List Standard) provides an international benchmark for quality that motivates improved performance. By committing themselves to meeting this global standard, site managers (in both formally protected areas and locations where other effective area-based conservation measures are in operation) seek to demonstrate and maintain performance and deliver real results.

The IUCN Green List Standard is organized into four components: Good Governance; Sound Design and Planning; Effective Management; and Successful Conservation Outcomes. The first three support the fourth. Each component has a set of criteria and indicators to measure its achievement.

Sites wishing to achieve IUCN Green List status must demonstrate, and then maintain, successful implementation of the IUCN Green List Standard. This is evaluated in two phases:

• Candidate phase: A voluntary commitment to the IUCN Green List Programme is followed by the start of the application process. This indicates whether sites meet the basic requirements for consideration. Sites then undergo an initial assessment against the IUCN Green List Standard. During the candidate phase, site managers learn what may need to be strengthened before the site can be further considered for inclusion on the Green List.

• IUCN Green List status: The management and representatives of the site are provided with a certificate, and the site is recognized and promoted by IUCN as a global exemplar in conservation.

Source: Derived from IUCN and WCPA (2017).
4. Assessment of the conservation status of wild species used as sources of human food in protected areas and gap analysis

As the protection of biodiversity in its natural environment has become more urgent, and spatial data for species distribution ranges have become available, various methods have been developed to better understand the performance of the protected areas network in conserving biodiversity (Rodrigues et al., 2004a, 2004b; Butchart et al., 2015). Global gap analyses have been conducted for several complete taxonomic groups, including seagrasses, cacti, mangroves, corals, lobsters, crayfish, amphibians, turtles, birds and mammals (Rodrigues et al., 2004a, 2004b; Butchart et al., 2015; Goettsch, Durán and Gaston, 2019). Although many species in these groups are important for food and agriculture, for example seagrasses, mangroves and corals that provide important habitats for commercial or artisanal fisheries, or species that are directly harvested for food and other products, no gap analysis has been conducted so far that specifically targets BFA.

This study provides the first analysis of the representation of species used for human food in the current protected areas network.

The IUCN Red List is the world’s most comprehensive information source for wild species extinction risk (IUCN, 2017) and contains a wealth of information on factors threatening species survival, including on distribution ranges, population trends, ecology, conservation actions, threats, trade and use. Today, The IUCN Red List includes 87,967 species (IUCN, 2017) of which 11 percent (9,627 species) are classified as being used for food by humans. Of these, a total of 1,783 species (18 percent) are listed in a threatened category (Critically Endangered, Endangered or Vulnerable), 609 (6 percent) are classed as Near Threatened and 1,218 (13 percent) are Data Deficient (Table 2). Almost half (48 percent) of the assessed species that are utilized for food are fishes (4,611 species). Birds account for 1,646, mammals for 1,237 and plants for 804. The latter include 14 crop wild relative species (out of a total 760 such species assessed globally for The IUCN Red List).

For this study, a spatial analysis of The IUCN Red List (Version 2017-2) and the World Database on Protected Areas (UNEP-WCMC and IUCN, 2018a) was undertaken to systematically identify gaps in the coverage of wild species used for food in the current global protected areas network.

An equal-area global hexagon grid, using Discrete Global Grids, was used to iteratively map every species and every protected area to the same grid system. A 6.2 km radius (or 100 km² area) was selected as the resolution in order to balance the level of accuracy and the number of computational iterations. Any cell fully or partially overlapped by a protected area was taken to have “protected” status. This means that if a species range overlaps with a protected cell it either (a) overlaps with a protected area or (b) is within 12.4 km of a protected area at maximum. This approach potentially introduces commission

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5 A species is classified as used for food by humans in The IUCN Red List when the species as a whole or any of its parts (e.g. fruits, leaves, stems, fins, eggs) are consumed by humans as a source of food. The information on the use of species as food can either come from the literature or from direct observation from the assessors evaluating the species.

6 Crop wild relatives are important species for improving food production and they are coded as "crop wild relatives" on The IUCN Red List, thus only if they are utilized as food for humans (i.e. the species or its parts are consumed) they are classified as food. Therefore, they are not strictly considered species utilized for human food in the present study. Also, the crop wild relatives included on the Red List at the time the study was conducted did not fulfil the requirements of belonging to a comprehensively assessed taxonomic group or having accurate distribution maps.
errors around the edges of species ranges, especially for range-restricted species. Given that the number of species with ranges smaller than 100 km² is 64 (or 0.8 percent of the total number of species analysed), the authors consider the resolution appropriate for a global-level analysis.

The approach used by Rodrigues et al. (2004b) was used to determine conservation targets for species based on their range sizes. For species with range sizes ≤ 1000 km², a requirement was set that their entire range (100 percent) needed to be covered by protected areas. For species with range sizes ≥ 250 000 km², the target was set at 10 percent. For species with range sizes between these values, targets were set using linear interpolations. For each species range, the total number of cells and the total number of protected cells were counted. The latter was then divided by the former to give the proportional coverage. If the proportion was greater than the species’ conservation target, the species was classed as a “covered” species. If the proportion was below the conservation target but greater than zero, the species was classed as a “partial gap” species. If the species did not overlap with any protected area, it was classed as a “gap species”.

Table 2. Total number of species classified as used for human food on The IUCN Red List of Threatened Species™ grouped by taxonomic class and IUCN Red List Category

<table>
<thead>
<tr>
<th>Class/ IUCN Red List Category</th>
<th>EX</th>
<th>EW</th>
<th>CR</th>
<th>EN</th>
<th>VU</th>
<th>NT</th>
<th>LC</th>
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<td>5</td>
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<td>359</td>
<td>575</td>
<td>849</td>
<td>611</td>
<td>5 949</td>
<td>1 218</td>
<td>9 627</td>
</tr>
</tbody>
</table>

Note: EX = Extinct, EW = Extinct in the Wild, CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern and DD = Data Deficient.
Source: IUCN (2017).
To avoid biases in the gap analysis, the focus of the study was on those taxonomic groups that have been comprehensively assessed and mapped for The IUCN Red List (e.g. amphibians, birds, sharks and rays). Areas of the range where the presence of the respective species was uncertain or extinct were excluded and only areas where it is native or reintroduced were considered.

To assess the protection status of protected areas, the criteria used in the Protected Planet Report (UNEP-WCMC and IUCN, 2016) were used to calculate protected area coverage. Specifically, this includes all protected areas, irrespective of their management categories, that have a spatially explicit boundary, except those that have “proposed” or “not reported” status. Point data in the World Database on Protected Areas (WDPA) were not considered due to their inherent spatial uncertainty. UNESCO Man and the Biosphere (MAB) (UNESCO, 2018) reserves in the WDPA were also excluded, due to their inclusion of large buffer areas that do not meet protected area definitions and would have erroneously inflated the coverage. A total of 214 879 protected areas were used in the analysis.

As noted above, a total of 4 243 species within the comprehensively assessed and mapped groups were identified as being utilized for food by humans (Table 3), of which 27 percent were estimated to be threatened with extinction (following the best-estimate calculation; Schipper et al., 2008, Hoffman et al., 2010). The selected groups of bony fishes had the highest proportion (29 percent) of species utilized for food, followed by sharks and rays (26 percent), the selected groups of crustaceans (26 percent) and mammals (21 percent). Where risk status is concerned, 4 percent (166) of the 4 243 species were classed as Critically Endangered, 8 percent (342) as Endangered, 13 percent (541) as Vulnerable, 10 percent (424) as Near Threatened, 60 percent (2 455) as being of Least Concern and 7 percent (315) as Data Deficient (Table 3).

Table 3. Number of species in the comprehensively assessed groups of The IUCN Red List of Threatened Species™ with mapped ranges and classified as used for human food

<table>
<thead>
<tr>
<th>Taxonomic group/IUCN Red List Category</th>
<th>CR</th>
<th>EN</th>
<th>VU</th>
<th>NT</th>
<th>LC</th>
<th>DD</th>
<th>Total</th>
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</thead>
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<td>20</td>
<td>34</td>
<td>22</td>
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<td>12</td>
<td>238</td>
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<td>191</td>
<td>1019</td>
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<td>1588</td>
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<td>9</td>
<td>6</td>
<td>158</td>
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<tr>
<td>Selected dicots</td>
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<td>4</td>
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<td>112</td>
<td>543</td>
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<td>20</td>
</tr>
<tr>
<td>Sharks and rays</td>
<td>6</td>
<td>27</td>
<td>57</td>
<td>51</td>
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<td>285</td>
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<tr>
<td>Total</td>
<td>166</td>
<td>342</td>
<td>541</td>
<td>424</td>
<td>2455</td>
<td>315</td>
<td>4243</td>
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</table>

Note: Figures indicate the number of species classified as used for human food in comprehensively assessed groups in The IUCN Red List grouped by IUCN Red List Category (CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, LC = Least Concern and DD = Data Deficient). Selected bony fishes = sturgeons, tunas, billfishes, blennies, pufferfishes, angelfishes, butterflyfishes, surgeonfishes, groupers, wrasses, seabreams, picarels and porgies; selected crustaceans = lobsters, freshwater crabs, freshwater crayfishes and freshwater shrimps; selected dicots = magnolias, mangroves; selected gastropods = cone snails; selected reptiles = marine turtles, sea snakes and crocodiles.

Source: IUCN (2017).
Among the species included in the analysis, 83 gap species (2 percent), 1,472 partial gap species (35 percent) and 2,688 (63 percent) covered species were identified. Looking at each taxonomic group separately, the highest proportion of gap species (4 percent) was among crustaceans, followed by mammals (3 percent) and birds (2 percent) (Figure 3). The groups for which the highest percentages of species met their conservation targets were birds (72 percent), sharks and rays (68 percent), selected bony fishes (65 percent) and mammals (56 percent). Among threatened species, 52 gap species (5 percent), 609 partial gap species (58 percent) and 388 covered species (37 percent) were found. The taxonomic groups in which the highest percentage of threatened species were found to be gap species were birds and mammals (6 percent in both cases), followed by amphibians (3 percent) (Figure 4).

The proportion of gap species identified among species utilized for food in the comprehensively assessed taxonomic groups is less than a sixth of the figure (12 percent, 3,090 species) found in analyses covering all 25,380 species within these taxonomic groups for The IUCN Red List (Butchart et al., 2015). In the case of mammals and birds, the 3 percent and 1.2 percent figures for species utilized for food compared with 9.7 percent and 5.6 percent, respectively, for these groups as a whole. The figure for the proportion of partial gap species among species utilized for food in the comprehensively assessed taxonomic groups (35 percent) is comparable to the 45 percent figure (11,368 species) found for all species within these groups. The figure for the proportion of covered species among species utilized for food in the comprehensively assessed taxonomic groups (63 percent) is higher than the 43 percent figure (10,922 of species) found for all species in these groups.

Figure 3: Protected area coverage of species in the comprehensively assessed taxonomic groups of The IUCN Red List of Threatened Species™ with mapped ranges and classified as used for human food

Note: “Gap” = species range not covered by protected areas. “Partial gap” = species range partially covered by protected areas but not to target level. “Covered” = species range covered to target level. Selected reptiles = marine turtles, seascakes and crocodiles; selected crustaceans = lobsters, freshwater crabs, freshwater crayfishes and freshwater shrimps; selected bony fishes = sturgeons, tunas, billfishes, bennies, pufferfishes, angelfishes, butterflyfishes, surgeonfishes, groupers, wrasses, seabreams, picarels and porgies. Comprehensively assessed taxa with fewer than 25 mapped species utilized for food are not shown. These correspond to conifers (1 species), hagfishes (4 species), seagrasses (4 species), selected dicots (magnolias and mangroves, 14 species), selected gastropods (cone snails, 3 species) and selected reptiles (marine turtles, seascakes and crocodiles, 20 species).

Source: Authors’ calculations using data from The IUCN Red List of Threatened Species™ version 2017-2 (IUCN, 2017) and the World Database on Protected Areas (UNEP-WCMC and IUCN, 2018a).
The current analysis found that 63 percent of gap species utilized for food are threatened. Even though the current network of protected areas offers adequate coverage to a high percentage of the species utilized as human food, most of these species (72 percent) are in the Least Concern category. Such species usually have wide ranges and therefore a relatively small proportion of their range needs to be covered for them to reach their conservation targets (Figure 5). Only 14 percent of covered species are threatened. These results are comparable to those found in global gap analyses, where threatened species − which frequently have smaller ranges − tend to fall outside the protected area network, while wide-ranging species tend to be better represented (Rodrigues et al., 2004a; Gruber et al., 2012; Akasaka et al., 2017; Goettsch, Durán and Gaston, 2019).

As noted in Section IV, there is currently little information on the status of management effectiveness in protected and conserved areas, leading some commentators to conclude that conservation by systems of protected areas is ineffective (Butchart et al., 2015). Because of this lack of information, the present study does not draw any conclusions regarding the effectiveness of conservation by systems of protected and conserved areas, other than to note the proportion of species used for human food whose ranges fall within the boundaries of such sites. Further analysis of the Global Database of Management Effectiveness (GD-PAME, maintained by UNEP-WCMC) or sites listed on the IUCN Green List of Protected and Conserved Areas in relation to the location of such species may provide more insight into the impact of protected areas on conservation status. This multidimensional analysis was beyond the scope of this study.
Notes: The comprehensively assessed and mapped taxonomic groups on The IUCN Red List are: amphibians; birds; mammals; selected reptiles (marine turtles, seasnakes and crocodiles); selected crustaceans (lobsters, freshwater crabs, freshwater crayfishes and freshwater shrimps); selected bony fishes (sturgeons, tunas, billfishes, blennies, pufferfishes, angelfishes, butterflyfishes, groupers, wrasses, seabreams, picarels and porgies); and sharks and rays. Green dots (•) correspond to covered species (i.e. those species that met their conservation target); yellow dots (•) are partial gap species (i.e. those species that partially met their conservation target); and red dots (•) correspond to gap species (i.e. those species without coverage).
5. Findings of a survey on links between protected areas and biodiversity for food and agriculture

The IUCN Green List of Protected and Conserved Areas (see Box 2) is a programme that aims to help protected area managers and other stakeholders achieve their conservation objectives. In this section, the findings of a survey on selected protected and conserved areas are presented. The sites included in this analysis are all “candidate sites” or “Green-Listed” on the IUCN Green List of Protected and Conserved Areas. They are therefore considered to be sites that are well planned, effectively managed, fairly governed and achieving their conservation objectives. Information from these sites regarding efforts to conserve BFA and perceptions about conservation actions of BFA should be relatively comprehensive compared to that from other sites.

A survey shared by IUCN in 2018 with managers of 50 participating sites of The IUCN Green List of Protected and Conserved Areas, both candidate sites and Green-List certified sites, received 29 responses from 22 countries across six continents, representing all major biomes, including forests, coastal areas and islands, and wetlands, and a range of designations including five UNESCO World Heritage Areas. They also represented every IUCN Protected Area Category (Table 1) and each IUCN governance type (Borrini-Feyerabend et al., 2013).

The survey results highlighted the close relationship that many protected areas have with agricultural practice and production and indicated a clear need for better support to protected-area managers in defining BFA and accounting for it in their conservation work. The main findings were as follows:

- 81 percent of respondents indicated that agricultural activity occurs within the boundaries and overall management area of their respective sites, and 83 percent reported that agriculture is a significant activity in the surrounding area;
- nearly 40 percent of protected areas from which responses were received are situated within an agriculture-dominated landscape – including 73 percent of “National Park” (IUCN Category II) designations;
- 90 percent of respondents indicated that they consider their protected area to deliver significant benefits to agricultural production, for example through ecosystem services such as insect pollination or water provision;
- only 35 percent of respondents indicated that they consider that it is necessary to include agriculture in management planning, and only 25 percent indicated that they deliberately include agriculture as part of their management operations.

As described above (Section V), based on an analysis of The IUCN Red List and the World Database of Protected Areas, 63 percent of species that are classified as being used for food by humans are covered by systems of protected areas. A high proportion of site managers (81 percent) that responded to the survey indicated that agricultural activity occurs within site boundaries. However, a possible bias in the sample should be noted, as respondents may be more likely to respond if the survey is on a topic that is of interest to them.

The survey also raises another interesting issue in that although most respondents recognize that some agricultural activity occurs within site boundaries, relatively few sites managers are actively engaging in specific site-management practices for BFA. This would indicate that within many so-called effectively managed sites, no specific conservation actions for BFA are undertaken, although it should be noted that the
sample size of the survey was relatively small. This finding raises questions about effective management of BFA across all protected and conserved areas, particularly in sites for which there is limited information about management practices. It also raises the question of whether protected areas do provide sufficient havens for BFA. Although, as shown by the gap analysis presented above, many components of BFA have ranges that are at least partially covered by protected and conserved areas, it remains unclear how effectively they are managed and conserved.

The survey found that site managers recognize that protected and conserved areas contribute to the provision of ecosystem services such as pollination or water provision to food and agricultural systems. Further research into these contributions and whether BFA truly benefits from protected areas, and the extent to which management activities can maintain or increase BFA, is required.
6. Concluding remarks and recommendations

This study provides the first overview of biodiversity used for human food included in The IUCN Red List and how it is captured by the protected area network. While many such species are “covered” by the protected areas network, a substantial minority are only partially covered (35 percent) or not covered at all (2 percent). Among threatened species, over half were found to be not covered or only partially covered. The finding that threatened species are relatively less well covered is similar to the findings of other global gap analyses of species coverage by protected areas and reflects the fact that threatened species tend to have smaller range sizes that fall outside the protected area network.

It is important to note that the analysis is based on limited data. Not all species utilized for food have been assessed for The IUCN Red List, and not all species included in The IUCN Red List have information recorded on their uses. Although use and trade are not currently part of the minimum required standards for Red List assessments, provision of this information needs to be encouraged as it would allow analyses of this kind to be more comprehensive and accurate, particularly because the utilization of species for food and human livelihoods is often an important consideration when making a case for species conservation.

It is also worth noting that representativity in The IUCN Red List is not consistent for all taxonomic groups. Only taxonomic groups that have been comprehensively assessed and mapped for The IUCN Red List were included in the gap analysis and hence some taxonomic groups widely used for food were not covered, notably fungi, plants and insects. Even though plants make up a large percentage of the species on The IUCN Red List, only a few were included in the analysis because only a handful of complete taxonomic plant groups had been assessed and had maps at the time of the analysis. Insects and other terrestrial invertebrates are under-represented in The IUCN Red List. There is also limited representation of marine species in The IUCN Red List. IUCN has identified priority taxonomic groups of marine fish, invertebrates, plants (mangroves and seagrasses) and macro-algae (seaweeds) for assessment.

Another taxonomic group for which there is limited information is fungi, and efforts are underway by IUCN to address this. Many European countries (31) have now produced national fungal red lists, and more than 5,500 different macrofungi are red listed in at least one European country. The national red list assessments indicate that up to 20 percent of European macrofungi may be threatened. There is an urgent need for long-term strategies for the conservation of habitats of arbuscular mycorrhizal fungi where they naturally occur and have evolved, through protected areas. This would allow for necessary adaptations and ecological interactions within specific ecosystems (Turrini and Giovannetti, 2012).

The IUCN Red List and the World Database of Protected Areas are dynamic datasets. New and repeat species assessments are constantly added to The IUCN Red List, and its geographic and taxonomic coverage will strategically broaden the coverage of the dataset, to include comprehensive species assessments of taxa currently under-represented, such as plants, fungi and invertebrates (Stuart et al., 2010), which include many species utilized for human food. Similarly, countries may gazette or degazette protected areas over time, and this is reflected in the World Database of Protected Areas. Revisiting and improving the analysis presented here on a periodic basis would therefore improve understanding of how many wild species are used for human food, the extent to which they are threatened with extinction and how well protected they are through systems of protected areas. The identification of the main threats affecting such species, which may include their utilization as food, and the establishment of priority sites for their conservation, are obvious next steps in improving conservation planning and sustainable use. A potential way to expand the present analysis would by including species that support food production such...
as pollinators, seagrasses and corals (which provide habitat for fish and other species important to food production). However, in order to include such species, information on the ecosystem services they provide needs to be captured systematically.

This study does not draw conclusions about the effectiveness of the sites analysed in terms of conservation and site management. Data from the Global Databases on Protected Areas Management Effectiveness (GD-PAME) were not used, and in their current form would have provided limited information on the effectiveness of the management of the species included in the analysis. As such, little can be said about the trends in extinction risk of those species identified as “covered” or “partially covered” by protected areas, and conclusions cannot be drawn about the effectiveness of protected and conserved areas in conserving them. An important piece of work would be to repeat or improve the analysis at intervals, assessing changes in species’ extinction risk over time in order to provide a better indication of the impact of protected and conserved areas.

The survey of protected area managers of sites considered to be effectively managed (through the IUCN Green List of Protected and Conserved Areas), shows that site managers perceive that protected areas provide significant benefits for food and agriculture, including through protection and delivery of ecosystem services such as pollinations and water provision. However, the survey had a low sample size, and relied on perceptions from site managers rather than on data on the extinction risk of BFA within IUCN Green-List sites. A specific assessment of biodiversity that overlaps with Green-List sites might provide greater insights into the effectiveness of conservation action for this biodiversity.

The exclusion of sites in the World Database on Protected Areas that lack spatially explicit boundaries or have only point data rather than polygons, UNESCO MAB reserves and sites defined as OECMs from the analysis may have affected the results. Such exclusions may have led to an underestimate of the coverage of species used for human food in protected and conserved areas. Notably, very little is known at present about the contribution of OECMs to the conservation of biodiversity. Further analysis, when data about the extent of the OECMs network are more comprehensive, may help to improve understanding of the network of both protected and conservation areas in relation to the conservation of BFA.

The location and extent of KBAs in relation to protected areas and the ranges of species identified as being used for human food in The IUCN Red List was not included in this study. This is because the KBA dataset was still under development at the time the analysis was done and it would therefore have required a great deal of data manipulation and more time than was available. Nonetheless, KBAs provide an additional data layer for the identification of important areas for biodiversity. The data would provide a more reliable spatial assessment of the location of BFA, and therefore a more accurate assessment of its coverage by systems of protected areas. Future analysis may take account of the coverage by protected and conserved areas of KBAs identified as important sites for BFA.

In summary, the study is an initial analysis of the contribution of protected areas to the conservation of species used for human food. Additional analyses, as set out above, may provide a clearer picture of how effectively protected areas conserve such species over time.
References


