Review

Emerging Patterns in Cultural Ecosystem Services as Incentives and Obstacles for Raptor Conservation

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Simple Summary: Ecosystem services are all the benefits that Nature provides to society. Some of these ecosystem services are tangible, such as the pollination of plants, the purification of water or the regulation of species abundance, which can all be quantified. However, cultural services deal with non-material benefits associated with spiritual experiences, cultural identity or aesthetic inspiration, which are hard to quantify. In this review, we analyzed studies in which cultural (non-material) and regulating or provisioning (tangible) services provided by birds of prey resulted in either positive or negative consequences for their conservation. We present possible scenarios for conservation outcomes drawn from how people perceive birds of prey, depending upon beliefs and knowledge (cultural services) of their associated tangible ecosystem services. We found that although ecosystem services are used to promote conservation initiatives, local knowledge and beliefs are key determinants of whether cultures protect, ignore, neglect or even persecute birds of prey. Thus, successful conservation initiatives require approaches that integrate social, religious and cultural aspects together with ecological research of the targeted raptor species, to generate specific environmental education programs for local stakeholders.

Abstract: The Millennium Ecosystem Assessment proposed four categories of ecosystem services as regulating, provisioning, supporting and cultural. Of these, cultural services have been the most difficult to quantify despite playing a key role in developing society’s supporting services to ecosystems. By reviewing a series of case studies related to the cultural services derived from raptors, we examine relations between tangible ecosystem services and ‘knowledge’ and ‘beliefs’ as part of supporting services from human societies to ecosystems. We identified types of raptor regulating and provisioning services and patterns in service–knowledge-beliefs that defined positive or negative outcomes for raptor conservation. We also demonstrate how possible interactions between physical, experiential, physical-symbolic and representative-symbolic cultural services and between different stakeholders can create incentives or obstacles for conservation. Predictable patterns in service-knowledge-beliefs provide a framework upon which socio-cultural and ethnobiological aspects of raptor conservation may be combined with ecological research to support conservation initiatives. Based on these patterns we present examples of how cultural services might be employed to better promote raptor conservation while respecting the beliefs and traditions of stakeholders.

Keywords: birds of prey; condors; eagles; ethnobiology; human-wildlife conflict; provisioning services; vultures
1. Introduction

Diverse animal, plant and microbial communities are vital for the proper functioning of natural ecosystems [1,2]. The conservation of biodiversity (that is the species, population and genetic diversity of living organisms), through the protection of animal and plant populations, therefore ensures the continued functional efficiency and resilience of wild areas. Biodiversity also bestows services to human-dominated and derived (e.g., parks, agricultural lands and production forests) ecosystems. The Millennium Ecosystem Assessment (MEA) has categorized these services as ‘provisioning’, ‘regulating’ and ‘cultural’ services with their underlying ‘supporting’ ecosystem services (Figure 1) [3]. Provisioning services are the services from Nature that supply human societies with commodities such as food, fibres, water and other resources (including, for example, ritual or medicinal animal and plant parts as commodities). Regulating services maintain the stability of ecosystems through pollination, water purification, carbon storage, decomposition and biological control. Supporting services are the services that support all other ecosystem services through habitat provisioning, soil formation, biomass accumulation, as well as water, nutrient- and gas-cycling. Finally, cultural services are the non-tangible services to humans that are derived from Nature, such as bestowing a sense of identity or a sense of place to people and cultures, or by providing some representative value in national emblems or as cultural or religious symbols (Figure 1) [3].

Figure 1. Supporting, provisioning and regulating ecosystem services and associated cultural ecosystem services as proposed by the Millennium Ecosystem Assessment (blue symbols). Note that provisioning and regulating ecosystem services have potential corresponding disservices for human societies (orange symbols). Nature can also provide cultural ecosystem disservices (e.g., the cultural disapproval of some species due to an unappealing appearance or behaviour). Human societies also affect the health, welfare and status of species through services to ecosystems that may be positive (e.g., conservation) or negative (e.g., exploitation). The nature of these ‘services to ecosystems’ is determined by supporting (dis)services that can be pastoral (light blue symbol) or exploitative (light yellow symbol). Note that cultural ecosystem (dis)services are directly related to supporting (dis)services from human societies to ecosystems.

Even before publishing the MEA, a large number of studies had attempted to place a value on the services provided by different components of ecosystem biodiversity, including communities, assemblages and species. Such studies often express the value of a species in purely monetary terms to convey the benefits of biodiversity for human societies and thereby justify actions for biological conservation [4–7]. Among the four categories of ecosystem services, three (i.e., provisioning, regulating and supporting) are closely linked to biodiversity’s functions in natural ecosystems; however, cultural services are somewhat unique as these are regarded as entirely linked to human societies and to a human ‘appreciation’ of biodiversity. This makes it difficult to ascribe a monetary value to
cultural services. As such, cultural services are often overlooked in ecosystem accounting. However, for wildlife conservation, there has been a growing recognition of the value of cultural services in driving actions and determining the success or failure of conservation programs [8–11].

Raptors such as eagles, hawks, kites, buzzards and owls include both apex and mesopredators [12,13]. There is increasing evidence to indicate that these species have key regulatory functions in natural ecosystems that largely determine the shape of trophic pyramids and the relative abundance of species at lower trophic levels [14,15]. Raptors are also generally beneficial to human societies by providing essential regulating services such as reducing bird, rodent and snail densities and thereby preventing damage to crops or limiting the spread of disease [16–20]. Raptors, particularly vultures, play an important role in disposing of rotting carcasses in wild areas including grazing commonage, in agricultural lands, and even in urban centres [21–23]. However, certain raptors, including vultures, will also kill livestock such as lambs and chickens, thereby generating human-raptor conflicts worldwide [24–29]. Raptors are also traded, kept as pets and used in sport [30–33], activities that represent raptor provisioning services for business stakeholders with often negative consequences for ecosystems and for conservation. These provisioning services are also closely related to raptor cultural services for collectors, and owners or falconers. Furthermore, many raptors are appreciated for their elegance or beauty by bird watchers, artists and photographers, are commonly used as national and regional emblems and are often prominent in folklore and story-telling [30,34,35]. Some raptors, particularly owls, are frequent antagonists in legends, mythologies and cultural narratives, often arousing fear or suspicion within target cultures [32,36,37]. The prominence of raptor cultural services suggests that regard for many species may be decoupled from their regulating and provisioning ecosystem services and disservices based on predominant cultural perspectives (see Section 6.2).

In this paper, we examine how cultural services can influence policies and actions around raptor conservation. We selected raptors as a focal group for our study because they are widely protected and have clear benefits for society as regulators of animal wastes such as carrion, or of invertebrate and vertebrate pests. Several species are apex predators that maintain trophic structures. Furthermore, many raptor species are associated with specific cultures, regions or nations through their use in symbols and emblems [17,30,35,38,39]. We examined case studies to demonstrate how cultural beliefs affect the perspectives of conservation stakeholders in the light of available knowledge to better appreciate or condemn raptors and thereby determine conservation outcomes. We first conducted a review of literature related to raptors and cultural ecosystem services and/or conservation. Based on the review, we developed a framework related to services, knowledge and beliefs from which to approach the investigation of cases from a perspective of cultural services. We used this framework to categorize case studies and thereby demonstrate how the broad nature (e.g., positive impact, negative impact and negative action) of provisioning and cultural services to different cultures/stakeholders derived from raptor species, may be linked to affect raptor conservation. We also identified culturally-related incentives, as well as potential obstacles and their possible remedies, to support the conservation of raptors while also respecting cultural beliefs and identities.

2. Review Methods

We retrieved research articles and reports, including non-peer reviewed reports, using Google Scholar for the period between 1990 and March 2021. Using combinations of search phrases that included ‘raptors’, ‘birds of prey’ or the different types of bird of prey (e.g., ‘hawk’, ‘eagle’, ‘kite’, ‘owl’, ‘vulture’, etc.) and words and phrases associated with cultural services, such as ‘cultural service’, ‘iconic’, ‘charismatic’, ‘belief’, ‘attitude’, ‘perception’, ‘religion’, ‘culture’, ‘education’, ‘tourism’ or ‘citizen science’, we retrieved 236 articles and reports. We reviewed the abstracts or full texts of these articles to eliminate papers or reports that made only cursory mention of some cultural services (e.g., ‘owls are associated
with misfortune’, ‘eagles are an attraction for tourists’), but without further supporting information (N = 126 papers). We also eliminated papers that presented no new data related to some specific case study (N = 6 papers) and papers that presented only perspectives or opinions (N = 7 papers). Three papers were in a language other than English, Spanish or French (N = 3 papers). Among the remaining articles, 24 were reviews or essays that presented information on aspects of bird or raptor cultural services, including information on the significance of raptors in ancient cultures, descriptive accounts of falconry or descriptions of the use of raptors in art or pottery; most reviews focused predominantly on tangible ecosystem services, only mentioning cultural services for completeness, but with only brief descriptions of such services (N = 24 papers). We used these reviews to snowball to other information sources, and to retrieve the original articles related to raptor cultural services. Based on initial engine searches and snowballing, we retained 120 papers; however, 23 of these were related to citizen science data and monitoring, or education and learning, without information on the attitudes of the key stakeholders (citizen scientists, teachers, students, etc.), and were, therefore, eliminated from our main study (N = 23 papers). We therefore retained 92 papers (see Supplementary Materials Table S1) for our main review.

3. Valuing Cultural Ecosystem Services

The recognition of a species’ ecosystem services and disservices (henceforth we use ‘(dis)services’ to indicate services and disservices as a group) will depend on the context of the species’ interactions with humans. For example, by consuming carrion, vultures provide an essential service to human societies where they remove decaying carcasses and animal wastes [23]; however, the same vultures may be viewed negatively by farmers who witness the birds feeding on dead or dying livestock [25,40]. Although the ‘actual’ values ascribed to a species’ ecosystem (dis)services can be estimated (albeit with great difficulty), the values as ‘perceived’ by stakeholders are often highly influenced by cultural (dis)services derived from the species, including culturally-based perspectives on the species [41–44]. Such (dis)services may be proximally linked to contemporary estimated values of the species’ ecological services or to past experiences with the species, but they may also be related to distant, historical interactions that have influenced the cognitive orientation of societies and cultures [30]. A species’ cultural service might also be completely detached from the ‘true’ values of its (dis)services because of its cultural symbolism in folklore, mythology or religion. As such, a species that bestows beneficial ecological services might be regarded as prejudicial or a nuisance (see Section 6.2), and a species with associated ecological disservices regarded as beneficial or valuable (see Section 6.4) depending on the stakeholder’s cultural perspective [44].

Despite the often-intangible nature of cultural services, which are specific to cultures and subcultures, including demographics within societies, political and social groups, educational level and even specific genders [34,44–50], attempts have been made to estimate the values (henceforth value estimates) of these services in monetary terms. As an initial step towards value estimation, the cultural services derived from a species can be placed into one or more categories: these include the physical and experiential uses of the species, the intellectual and educational uses of the species or the spiritual and symbolic roles of the species [51–53]. In the context of raptors, certain cultural services can be variously linked to more easily quantifiable provisioning services. For example, the trade in raptors is sometimes associated with raptors’ physical and experiential use, and the use of raptor feathers, claws or bones can be linked to certain religious or cultural practices (e.g., as ornamentation in traditional dances, or ingredients in traditional medicines [30,54–57]). We regard these latter as ‘physical spiritual, emblematic or artistic’ uses (henceforth ‘physical-symbolic’). Finally, raptors will often provide significant spiritual, emblematic or artistic services that are entirely representative without any direct physical association with the birds (i.e., representative spiritual, emblematic or artistic [58,59]—henceforth ‘representative-symbolic’).
Cultural value estimation is often based on evidence of the willingness to pay for services, either directly or indirectly. For example, donations to raptor conservation organizations may be regarded as payments for raptor-related cultural services. The cultural value of raptors in tourism can be partially estimated using information on the distances travelled by bird watchers to arrive to nature reserves and raptor viewing locations (indirect measure), by recording expenditure related to bird-watching equipment (indirect) or as entrance fees to raptor viewing sites or to raptor shows (direct) [35,60,61]. Based on these examples, it is clear that monetary value estimations are more easily associated with the physical and certain experiential uses of the species. Furthermore, representative-symbolic uses of wildlife might best be valued in terms of their proportional contributions or key placements in aspects of culture—including the nature of their roles in governing emotions, or in nurturing a sense of identity or a sense of nationhood. The value estimates of cultural services might therefore be more qualitative than quantitative [8,34,62]. Documenting and recording such cultural services is, nevertheless, an important exercise because cultural services can ultimately determine the nature of human individual and community interactions with raptors, and whether such interactions are likely to be beneficial or prejudicial to the raptors [47,62,63].

Regarding raptor conservation as a service from human societies to ecosystems (i.e., societies services to ecosystems [64]), cultural services may be expected to play a major role in the implementation and success (or lack of success) of conservation actions [11,35,65]. As indicated in Figure 1, cultural ecosystem (dis)services will be directly linked to the ‘supporting (dis)services’ that underly conservation management of ecosystems. Typical supporting services to ecosystems might include conservation policy as derived and directed from society’s appreciations of Nature, from society’s ethical understandings of Nature’s intrinsic rights and from stakeholder’s religious or cultural connections to landscapes or species, including those derived from sense of place, heritage and emblems [64]. Each of these supporting services is closely connected with cultural knowledge of species and beliefs related to the species. In a recent review by Horgan and Kudavidanage [66], the success of conservation projects as indicated by the restoration of species populations, the protection of habitats or the reduction of negative impacts on wildlife was frequently associated with tangible benefits to communities. These tangible benefits included payments for ecosystem services, community participation in conservation planning and/or clear community incentives for conservation actions. Community incentives are often related to projected monetary gains through, for example, ecotourism, including gains for private-sector businesses [60,67]. However, community incentives related to other, non-tangible gains (e.g., satisfaction of place, sense of endowment and feelings of connectedness with ancestors) from conservation actions are seldom considered in project reporting.

4. Forming Cultural Perspectives on Biodiversity

Based on the role of cultural services in conservation praxis, the recognition of cultural perspectives becomes a key step in incorporating fundamental or realized cultural services from biodiversity, as components of supporting services to ecosystems. Where a species’ regulatory or provisioning ecosystem services are recognized and appreciated by local cultures, then conservation based on these tangible services might gain essential support from local communities (Figure 2). However, because culture itself changes in time and space, and is largely determined by prevailing value systems [45,46,63], then cultural perspectives can also vary within and between cultures, can change over time, and will be variously linked to utilitarian and emotional values.

Figure 2 indicates how culturally held knowledge and beliefs can influence community-based management actions. The figure represents cultural perspective as viewed through two or more lenses. The first lens is a ‘knowledge’ or ‘science’ lens. Cultural and scientific knowledge about a species are both gained from research and education. Knowledge of the species may be largely derived from western approaches to science where information is documented and stored as written or digital form; but it will also include elements of
traditional knowledge that are communicated through ritual and the spoken word \[63,68\]. The knowledge lens therefore depicts a species based on recorded or remembered interactions with the species that are mainly physical or experiential. Even when based on current science, knowledge is distorted through a series of inherent biases including reductionism, sampling bias or confirmation bias \[69\]. Nevertheless, this lens is principally knowledge-based and likely to more accurately reflect the reality of a species’ ecological services compared to the second, belief lens. The knowledge and science lens can greatly influence conservation and resource management policy where knowledge is effectively communicated to policy makers (Figure 2).

**Figure 2.** Components of ecosystem functions (EF), tangible ecosystem services (regulating (R) and provisioning (P)) and associated supporting services to ecosystems as derived from knowledge (K) and beliefs (B) viewed through associated knowledge (L1) and belief (L2) lenses. Note that conservation ‘policy’ (without voting referendums or direct community representation) is largely derived from knowledge and science. Green symbols indicate positive ‘values’ or services, orange symbols indicate negative values or disservices. (A) indicates a case whereby a cultural disservice, related to community beliefs, negates a recognized ecosystem service to become a potential barrier to conservation. (B) indicates a scenario whereby a cultural service related to some community belief disregards a recognized ecosystem disservice to support a conservation initiative. Note that knowledge and/or beliefs will not exist for all raptor species—in many cases, cognitive associations with raptors will be weak (positive or negative) or neutral.

The second lens is the ‘belief’ or ‘opinion’ lens. This too may be based on knowledge and reported science, but can be heavily affected by story-telling, myth or religion, which tends to be more influenced by emotion than is science, and therefore is often less objective. Figure 2 presents two hypothetical cases to demonstrate how knowledge and belief lenses might function in raptor conservation. The first case demonstrates how some raptor species can have direct benefits to Nature and human societies that are recognized by science, but where strong cultural beliefs override scientific knowledge to view the species in negative terms (see examples in Section 6.2) (Figure 2A). Such negative beliefs and opinions may be regarded as supporting disservices from human societies to ecosystems that are directly derived from the species’ cultural disservices as depicted in Figure 1. Beliefs can also result in positive views of raptors with documented ecosystem disservices, as depicted in the second example (see examples in Section 6.4) (Figure 2B). Although science-based policy is essential to conservation, it is community action—often dictated by cultural beliefs and value systems, and more proximate to implementation—that eventually determines the success of conservation policy \[66\].
5. Cultural Perspectives on Raptors and the Impact on Conservation

As depicted in Figure 3, there are eight possible positive or negative service-knowledge-belief combinations determining associated positive and negative appreciations of species. We refer to these eight possible combinations as ‘scenarios’. Each scenario might have predominantly positive or negative consequences for conservation. However, we predicted that provisioning (dis)services (both beneficial and prejudicial) will override knowledge and beliefs to affect outcomes (community actions), particularly among economically disadvantaged stakeholders and in developing countries, and that beliefs will override knowledge during implementation at community levels in both developed and developing countries. As indicated in Figure 3, we hold that all raptor species have benefits for Nature (ecosystem functions) (scenarios S1–S4), but that there may be cases where certain raptors are either beneficial (scenarios S1–S4) or prejudicial (scenarios S5–S8) to society (ecosystem (dis)services). There may also be cases where prevailing knowledge has viewed the species in predominantly negative terms (i.e., erroneously regarding a species as invasive or damaging to livestock) (scenarios S3–S4), but that this view would later change (indicating a science or knowledge bias that was later rectified) to finally recognize prevailing benefits. Examples might also exist of cases where prevailing knowledge underestimates some disservice (scenarios S5–S6). Such knowledge biases may be easily corrected in scientific records or in policy, but might linger in cultural memories. Finally, regardless of whether science holds a species as beneficial or prejudicial, cultural beliefs, based on emotion or past experience might alter that view to either reinforce or reverse science-based information (scenarios S2, S3, S6 and S7).

Figure 3. Eight potential service-knowledge-belief combinations (scenarios) that might produce barriers or pathways to conservation. Green symbols indicate ecosystem functions (EF), regulating (R) or provisioning (P) ecosystem services, and knowledge-based (K) or belief-based (B) cultural services; orange symbols are corresponding regulating, provisioning or cultural disservices. L1 is the knowledge lens and L2 the belief lens. Provisioning (dis)services (P) are positioned closer to the supporting services (K and B) to indicate a greater influence on stakeholder appreciations of species; however, the order of R and P may differ between stakeholders and do not necessarily have similar positive or negative values (e.g., Figure 2B). We do not include combinations with ‘neutral’ values—although examples of stakeholders indicating ‘no knowledge’ and/or expressing ‘no beliefs’ are common in social studies related to specific raptors.
6. The Role of Knowledge and Beliefs in Human-Raptor Interactions—Example Scenarios

6.1. Knowledge and Beliefs in Harmony with Ecosystem Services (S1)

There are numerous examples of raptors having beneficial regulating ecosystem services (either as predators or scavengers) that are acknowledged by stakeholders that sometimes support conservation initiatives. In some cases, stakeholders may attempt to maximize potential regulating services by providing structures to attract raptors or to enhance their regulatory functions. For example, owls, hawks, kestrels and kites are recognized by farmers and pest managers in many countries for their contributions in limiting populations of pest rodents, birds and snails. In some regions, pest managers will enhance agricultural habitats to promote raptor activities by, for example, installing owl boxes or perches adjacent to crops [19,20,35,70,71]. Recognition of regulating ecosystem services is also principal among the justifications for conservation used by many raptor-related NGOs and other organizations [65] and as justification for research by the scientific community [35,72–74]. In these latter cases (conservation and science), raptors will often provide a related provisioning service by attracting donations and funding. However, despite the widespread recognition of raptor pest-regulating services, farmers are rarely proactive in encouraging birds on their properties [19,54,75]. For example, Snail Kites (Rostrhamus sociabilis) have exhibited a population explosion in Ecuador in response to invasive apple snails—but farmers take no actions to encourage the birds on their properties, despite acknowledging that the kites consume snails and that snail predation could be enhanced through improved crop management [19]. This indicates that S1 positive knowledge and beliefs will not necessarily lead to positive outcomes for conservation. Similarly, vultures in many parts of the world are associated with meat markets, fisheries and the open-air disposal of animal wastes. In some cases, this results in high densities of scavenging birds that gain association, including some cultural significance, with certain districts, cities or islands [22,23]. These associations and the recognized benefits derived from vultures often promote a prevailing acceptance of the birds, albeit without proactive conservation actions. The supplementation of food resources by butchers, abattoirs and fishermen can be regarded as a stakeholder associated service to ecosystems that increases the densities of certain raptors [11,22], and possibly also their welfare.

Stakeholders may be more proactive where they also directly benefit from some provisioning service provided by the raptors. For example, scavenging by vultures in India leaves clean, dry animal bones that are collected for fertilizer production and offer income to resource-poor communities [76]. Furthermore, local communities, national parks and raptor sanctuaries may all gain from revenue derived from raptor-based tourism [60,61,67,77]. In each of these cases, knowledge of the birds and beliefs about their roles in natural and derived ecosystems can be a justification for conservation actions, and the birds are likely to be viewed positively. However, for many stakeholders, knowledge and sentiments concerning raptors are often neutral, unclear or remain undocumented. Where raptors provide beneficial provisioning services to one group of stakeholders, then services to ecosystems are generally resilient to neutral knowledge and sentiments (e.g., disinterest or lack of familiarity) from other stakeholders [67,78]. For example, in the case of some tourists, who are often major contributors to raptor conservation, derived cultural services can be based on curiosity, which implies interest, but without underlying knowledge and/or beliefs (lack of familiarity).

Because many raptors are highly sensitive to disturbance or occur at very low densities, then certain provisioning services are antagonistic to conservation efforts (note that these are not regarded as provisioning disservices because they still benefit the human stakeholders). For example, the capture of wild raptors for the pet and falconry industries, or for use of their body parts in traditional arts or medicines, can have significant impacts on certain raptor species. In most cases, such activities are entirely illegal, despite having often historic cultural origins [31,37,55–57,79]. In these cases, the illegal trade in raptors is driven by positive attitudes concerning the birds from other stakeholders, and even from reverence for certain birds that have significant physical or representative value for client
cultures (e.g., persons interested in traditional ornaments, traditional medicines or who admire birds) [54,55,57].

For many cultures, knowledge of the positive regulating or provisioning services from raptors coincides with positive beliefs and a positive perception of the species. However, in some cases, knowledge of tangible ecosystem services may not be explicit to positive beliefs. For example, among some aboriginal tribes of Australia, the Wedge-tailed Eagle (*Aquila audax*) is central to many dreamtime stories and therefore has a spiritual connection with the cultures [30]. Among Parsees and other Central Asian peoples, vultures, apart from scavenging on animal carcasses, are also encouraged to feed on human remains as part of the cultures’ funeral rites [80,81]. Among some adherents of the Hindu faith, vultures are associated with Jatayu—the vulture saint [80]. In South America, condors hold strong cultural and spiritual connections with people in the Andes, as well as significant national emblematic value [30,34,55], and in parts of the USA, Ospreys (*Pandion haliaetus*) are so admired that platforms are erected to encourage their nesting, thereby resulting in often unexpected benefits, such as deterring the predators of livestock [82]. Indeed, there are clear links between raptor-based ecotourism or other cultural services and a potential restoration of ecosystem functions through the encouragement or establishment of birds of prey [61,83–86]. Positive perceptions of birds of prey may also support the conservation of wild areas or habitats that are favourable for the birds; for example, the suitability of alfalfa farms for birds of prey has been proposed as an incentive to maintain alfalfa production in the face of pressure from higher value crops [87].

6.2. Beliefs Counter Knowledge of Ecosystem Services (S2)

Knowledge can be biased because of limitations in documenting or reporting different classes of information. Beliefs and personal opinions may also act as filters that give prominence to supporting information (confirmation bias) and discount or overlook contrary or inconvenient information. In sub-Saharan Africa, Mackinder’s Eagle Owl (*Bubo capensis mackinderi*) preys upon rodents and other agricultural mammal pests, limiting rodent populations [54]. Interviews revealed that a majority (75%) of farmers in the Nyeri district in Kenya know about these beneficial regulating services, but predominant beliefs about the owls were often neutral (44%) or negative (30%). Most of the farmers (82%) believed that owls are associated with death, and 10% perceived owls as ‘bad omens’. Because of these beliefs, farmers preferred to use pesticides to control rodent pests, without regard for accidental poisoning of the owls. Similar cases have been documented in other regions of Africa, particularly among older people who associate owls with death or misfortune [47,54,88]. Near Esquel City (Argentina), the Barn Owl (*Tyto alba*) and Pygmy Owl (*Glaucidium nana*) display marked numerical responses during outbreaks of rodents caused by the mass fruiting of native bamboos. Despite benefits from owls as predators of rodents, 61% of subjects interviewed during a study by Molares and Gurovich [36] considered the owls as ‘diabolic birds’ for which they have no sympathy.

As a further example, falcons and hawks have increased in many urban areas in recent decades, partly due to deliberate releases, due to often abundant prey or other foods, and due to the installation of nesting boxes [89,90]. In the USA, falcons will commonly prey on Feral Pigeons (*Columba livia domestica*), thereby helping to regulate pigeon populations [91]. However, observations of falcons killing pigeons can sometimes create a negative perception of the falcons: across a number of cities in the USA, ‘pigeon enthusiasts’ expressed their dislike of falcons precisely because of their natural preference to hunt pigeons, consequently, >1000 raptors are killed in cities such as Los Angeles and Portland each year by shooting, beating or poisoning [92]. In each of these cases, negative beliefs or a negative perception of the raptors prevailed despite widespread knowledge of clear ecosystem services. In the case of urban dwellers, the negative sentiments likely stem from feelings of ‘disgust’ around the predation of relatively defenceless pigeons. In all these cases, negative emotions toward the raptors create barriers to their conservation despite knowledge of ecosystem services.
6.3. Prevailing Knowledge Creates Misconceptions around Ecosystem (Dis)Services (S3–S6)

For completeness, we included four possible ‘service-knowledge-belief’ combinations in Figure 3 that imply a disconnect between the knowledge and reality of raptor ecosystem services. The four possibilities are that prevailing scientific knowledge misrepresents tangible services (S3, S4) or tangible disservices (S5, S6) from raptors to support (S4–S5), create (S4–S5) or counter (S3, S6) prevailing beliefs. These scenarios are apparent where information has been updated to clearly refute previous knowledge biases. There are numerous examples of changes to contemporary scientific views, many of which have also required changes to policy. In many of these cases, raptors were considered as vermin—a view that was sometimes promoted by scientific authorities [93,94]. A current understanding of these same raptor species recognises, or focuses on their benefits to society, even though some species may occasionally damage livestock or game [11,35,95]. Previous, biased knowledge that affected policy has been responsible for the largescale killing of raptors in the past, including such iconic species as the Andean (Vultur gryphus) and Californian (Gymnogyps californianus) Condors. Indeed, government bounties were offered in many countries to control a wide range of raptor species [94,96]. Such biased knowledge that focused on disservices may be responsible for lingering beliefs among some farmers that raptors kill or damage livestock (see Section 6.5). Furthermore, the distribution of bounties created a reinforcing provisioning service for farmers and hunters that likely perpetuated stories of raptor disservices. Current schemes that compensate farmers for raptor damage to livestock, although not directly linked to raptors and, therefore, not a provisioning service—may also perpetuate stories of raptor disservices and foment negative biases among farming communities [97].

Even in modern times, a lack of understanding of the biology and behaviour of raptors has resulted in widespread human (farmer)-raptor conflict. For example, it is now widely accepted that the collection and burial of livestock cadavers from commonage for sanitary reasons resulted in facultative scavengers pursuing and sometimes killing still-living animals [11,25,35,98]. Raptor researchers are careful to point out that legislation aimed at a similar management of animal wastes in some developing countries might also result in human-raptor conflict. However, conservation practitioners now have some of the necessary knowledge to avoid the problems of the past—either through diversionary feeding, by offering financial incentives to maintain breeding birds of prey or their nests, thereby countering possible persecution, or by strengthening potential cultural services [23,98–101]. Based on Figure 3, where information is biased (S3, S6), skeptics—particularly those among the scientific community—play a key role in correcting and updating that knowledge.

As an example of an S6 scenario, Bonta et al. [68] describe how traditional aboriginal knowledge and ceremonies recognized birds of prey such as the Black Kite (Milvus migrans), Whistling Kite (Haliastur sphenurus) and Brown Falcon (Falco berigora) to intentionally spread fire using burning sticks. Because of scepticism from scientists and land authorities, the role of avian fire-spreading in savanna ecosystems has been largely ignored and fire management consequently hampered. Bonta et al. [68] suggest that by incorporating knowledge of fire-spreading into fire ecology, management practices for fire-prone Australian savannas could be improved. As researchers become more aware of avian fire-spreading, observations from other regions might update existing knowledge and beliefs that view certain raptors as providing purely beneficial ecosystem services (i.e., Scenario S5). It should be noted, that augmented damage to livestock by eagles and vultures during times when diversionary food sources were unavailable, represents a further case where raptor provisioning disservices—as observed by farmers—were more frequent than prevailing scientific knowledge would have suggested, and that some critique on that knowledge was required to find a workable solution that eventually abated the conflict [11,35].
6.4. Beliefs Override Knowledge of Ecosystem Disservices (S7)

Deep, positive sentiments about the intrinsic rights of wildlife, including raptors, offer resilient support for conservation initiatives, particularly where sentiments allow individuals or cultures to see beyond any apparent disservices from wildlife. At the level of individual persons, or narrow groups (such as conservation practitioners or wildlife-friendly farmers), such positive beliefs will not be surprising. However, widespread beliefs in the intrinsic rights of animals, despite potential ecosystem disservices are prevalent in many cultures. For example, among Sicilian farmers, pride in ‘hosting’ golden eagles and respect for the eagles (known as ‘Sos Verbos’) allows farmers to downplay rather than exaggerate potential livestock losses to the birds [26]. In Delhi (India) Black Kites provide an essential ecosystem service in consuming carrion, but the birds are often aggressive and will attack passers-by, particularly during the breeding season. Nevertheless, surveys of persons affected and even injured by these aggressive birds revealed strikingly positive attitudes and widespread sympathy for the birds [22,102]. Much of this empathy was related to religious symbolism, with Muslims seeing the kites as ‘emissaries’ that carry sins, worries and prayers towards the heavens, and Hindus seeing them as part of a oneness with all living creatures and a connection to one ultimate God form [22]. There are many similar cases of animals, including species associated with provisioning disservices such as Peacocks (Pavo cristata) in Sri Lanka, that are protected because of their positions in religious or cultural symbolism [103]. Such sentiments of intrinsic animal rights and a sense of connectedness to specific animals may be gaining traction among other cultures and religions as humans become increasingly aware of the challenges for wildlife to survive in a human-dominated world [104]. As indicated by the above examples, tolerance of raptors and other wildlife in the knowledge of ecosystem disservices, which is a key component of conflict resolution, must come from non-material value systems. Such systems may remain fundamentally anthropocentric because they represent human links to saints and deities or an upholding of traditions, but they might also come from more fraternal notions of human-Nature relationships linked to specific world views and spiritualities [104,105].

6.5. A Focus on Ecosystem Disservices Generates Ill-Will toward Raptors (S8)

As predators of mammals and birds, raptors do not seem to discriminate between wild and domesticated or semi-domesticated animals as food. In some cases, individual birds or local populations of raptors will find more vulnerable targets among domesticated livestock, particularly during synchronized birthing or where animals lack cover from tall vegetation or protective buildings and fences [24,40,99,101,106–108]. Several raptor species will also consume game animals such as rabbits, grouse and partridges. Evidence suggests that whereas raptors may limit the numbers of game animals, they do not deplete populations [65,109]. Nevertheless, many game managers regard raptors as pests, or at least over-abundant, and may consequently be antagonistic toward conservation initiatives [65,109–111]. A number of general observations suggest that a focus by stakeholders on these regulating and provisioning disservices produces a bias in their understanding of the biology and ecology of the predators (a cultural disservice). Such biases are difficult to counter because farmers and livestock managers are notably risk averse and, as in many cases of pest management, will tend to exaggerate losses and therefore feel compelled to take actions [41,42]. For this reason, and despite legislation that protects raptors, human (farmer)-wildlife conflict remains a considerable challenge to raptor conservation as indicated by a range of examples.

In the Lazio region of Italy, data collected between 2000 and 2011 from a wildlife rehabilitation centre showed that, despite raptors being protected by law since 1977, shooting was the main cause for admission of Falconiformes (excluding kestrels) (52% of a total of 1233 individuals), particularly in suburban areas [112]. Similar trends, though with a lower proportion of gun-wounded raptors than in the previous study, have been reported by other wildlife rehabilitation centres in Spain [113], and to a lesser degree in the USA [114] and Canada [115]. Several studies in the UK have documented the long-standing persecu-
ation of Peregrine Falcons (*Falco peregrinus*) and Hen Harriers (*Circus cyanus*) in moorlands managed for sport shooting of Red Grouse (*Lagopus lagopus scoticus*) [110,116,117]. However, both grouse and raptor numbers have been declining for decades throughout the UK, mainly due to habitat change [110]. Moleón et al. [118] reported a similar human-raptor conflict in southeast Spain, where, despite low eagle predation rates (0.3–2.5%), local hunters claimed that predation by Bonelli’s Eagle (*Aquila fasciata*) had depleted Rabbit (*Oryctolagus cuniculus*) and Red-legged Partridge (*Alectoris rufa*) populations. Misconceptions around the impacts of scavenging vultures also occur. Ballejo et al. [40] indicate that 92% of livestock farmers interviewed in the Patagonia region of Argentina perceive both obligate and facultative scavenging vultures as harmful to livestock without any documented support for these claims. Similar cases of exaggerated perceptions of raptor-related livestock mortality have been reported in other countries [54,119,120]. Duriez et al. [25], investigated 156 complaints of vultures (mainly the Griffon Vulture (*Gyps fulvus*)—an obligate scavenger) attacking livestock in the French Pyrenees. The study indicated that only 18% of the cases had evidence of vulture attacks, and most of these related to attacks on immobile animals that were close to death. Perhaps due to similar misconceptions, at least 243 Griffon Vultures were poisoned in northern Spain between 2006 and 2010, worsening the already precarious conservation status of this and other threatened vulture species [11]. In each of these cases, prevailing sentiments and beliefs among the key game manager and farming stakeholders are likely to be influenced by a filtering of information that reinforces their risk aversions [43]. This will also produce a distrust of conservation organisations and a rejection of conservation policy in favour of sentiments around the right to industry and beliefs that, without aggressive management, economic losses would be considerable [65,121].

7. Translating Cultural Supporting (Dis)Services to Ecosystems into Conservation Actions

We categorized cultural ecosystem services and disservices into four main types: these are physical, experiential, physical-symbolic and representative-symbolic (Figure 4) and identified some prominent patterns in service-knowledge-belief systems related to raptors (Figure 3). These patterns are likely to occur with other stakeholder-wildlife systems also—and therefore represent a convenient framework to map perspectives to tangible services and conservation outcomes. In our review, we focused on studies with relatively defined subject cultures/stakeholders, but most of the studies indicated that such subject groups will already represent persons with heterogenous knowledge and beliefs [26,34,45,46]. Furthermore, when considering raptor conservation, different stakeholders will interact with each other from the perspective of prevailing provisioning (dis)services and cultural (dis)services gained from the target species (Figure 4). Mapping such connections can help support conservation efforts as indicated by the example of the Andean Condor in Figure 4. In this case, based on associated literature, innocuous representative-symbolic services might determine ancillary physical or physical-symbolic services, or provisioning services with undesirable outcomes for conservation.
Figure 4. Possible connections between non-tangible cultural services and tangible provisioning and regulating services derived from the Andean Condor (*Vultur gryphus*). Green lines (+) and symbols indicate services with benefits for condor conservation, red lines (−) and orange symbols indicate services that counter conservation efforts and yellow symbols remain undefined (see text). Information related to the Andean Condor is taken from Williams et al. [55], Rendón and Bidwell [67], Sault [34], and Zuluaga et al. [122]. Andean Condor adapted image by szke licensed under CC BY-NC-SA 2.0.

7.1. Supporting Services to Conservation where Knowledge and Beliefs Recognize Raptor Services (S1 Cases)

Our review of S1 cases indicated that where knowledge and beliefs reflect an understanding of the services derived from raptors, then the outcomes for conservation will generally be positive. However, whether outcomes were positive or negative for raptors did depend on the nature of the provisioning services: where provisioning services were related to raptors in science and conservation (e.g., linked to research or other funding) or tourism then outcomes tended to be positive, but when related to a direct trade in birds or their body parts, then the outcomes were mainly negative. In many of the cases we reviewed, knowledge of tangible services reinforced support for conservation and the protection of birds when this knowledge provided associated positive cultural values through connections with tradition or religion. Such positive, reinforcing beliefs and sentiments can be promoted by drawing on connections to culture. The use of raptors as national birds or in national or regional emblems can promote positive attitudes towards the birds and increase willingness to support conservation efforts [78,123]: for example, following designation of the Philippine Eagle (*Pithecophaga jefferyi*) as the national bird of the Philippines, several private sector businesses, including multinationals, became visible donors to conservation efforts [78].

The promotion of wildlife as emblems can, however, also have unforeseen negative consequences. For example, following designation of the Javan Hawk-Eagle (*Spizaetus*...
Birds bartelsi as Indonesia’s national bird, the illegal capture and trade in Javan Hawk-Eagles intensified as demands to possess such a rare and iconic bird increased [79,124]. Similarly, there are indications that the demand for owls as pets increased in some Asian countries after several different species of owl featured in the Harry Potter movies [32]. In such cases, strategies may be adopted to pre-emptively prevent representative-symbolic services from translating to physical cultural and provisioning services (Figure 4). Such strategies may include the provision of supporting conservation legislation at the same time that a species is adopted as a national or regional emblem [78,79] or support from the beneficiaries of representative cultural services for conservation initiatives [125].

The use of feathers and body parts as physical-symbolic services, even when coming from a position of respect for the target species, is likely to generate some demand for body parts, and will potentially drive the illegal hunting of raptors (Figure 4). However, cultural services must be respected and traditions allowed to continue if conservation practitioners are to avoid conflict with other stakeholders, including traditional cultures living near wild areas. In such cases, it may be more advantageous to source materials from captive animals, to legalize and regulate some trade or to restrict the trade to affected cultures [126]. The use of new technologies, such as the elemental or genetic analyses of animal products, can help regulate such limited trade and prevent the inclusion of illegally wild-caught animals or their body parts into legalized trade [127,128]. It may also be possible to substitute physical symbols with substitutes derived from domesticated birds. Substituting such symbols has occurred in historic times among cultures faced with changing climates or changing abundances of wildlife [129,130].

Some cultural practices will be immediately incompatible with conservation. For example, the killing of Honey Buzzards (Pernis apivorus) in Sicily and Calabria (Italy) has been used to symbolize male virility [112]. In such cases, it may be possible to develop new outlets for cultural expression by working with those cultures towards changes in attitude. For example, ritualistic animal releases as practiced by some Buddhists have been linked to the spread of several invasive species [131,132]. Such practices can be modified or curtailed: careful guidelines that allow the continuing practice of animal releases and are compatible with conservation goals have been adopted though Buddhist temples in some affected regions. Indeed, simply educating devotees about the conservation implications of animal releases has been shown to reduce the probability of releases [131].

Tourism is one of the most successful approaches to deriving provisioning services from raptors while still promoting experiential cultural services. Raptors are significant tourist attractions in many countries [60,61,67]. However, eco-cultural tourism can sometimes feed into physical and representative-symbolic services observed among local cultures to produce physical cultural services among non-local tourists that run counter to conservation goals [55] (Figure 4). As an example, the purchase of ritualistic paraphernalia by tourists, while associated with the tourist’s experience of place and appreciation of local cultures, can also support an illegal trade in raptor body parts [55]. Eco-cultural tourism must attract the right type of tourist—a tourist that is aware of the conservation and wildlife protection laws of the visited region while still supporting local economies and respecting local cultures [67,77]. Recent increases in the numbers of tourists seeking ‘mystical’ experiences [133,134] should be addressed by better linking conservation goals with this emerging form of tourism and with key industry stakeholders.

7.2. Supporting Services to Conservation where Beliefs Counter Knowledge of Raptor Services (S2 Cases)

Negative beliefs and sentiments about raptors in the face of knowledge of their beneficial services are a difficult obstacle in raptor conservation. Our review of cases indicated two origins for such cultural disservices. The first derives from cultural heritage that connects raptors with demons and deities [47,54,56,135]; the second stems from the innate tendencies of people to anthropomorphise animals, thereby viewing raptors and other predators as cruel and blood-thirsty, or viewing vultures as dirty [136]. It may be more difficult to change long-held traditional beliefs, although evidence suggests that these are
waning among younger people [47,137]. Although the result of anthropomorphising in these cases is associated with negative sentiments for raptors, associating animals with human attitudes and behaviours is still a form of empathy, and could be encouraged to result in more positive outcomes. For example, strategies that disconnect negative sentiments from raptors might include a transitioning of cultural narratives away from certain species and toward specific mythological or story characters (i.e., Satan is represented as a snake or as snake-like, but snakes do not represent Satan). New methodologies to advance the study and incorporation of such beliefs about animals into conservation biology are certainly warranted [62]. These methodologies will necessarily respond to local traditions and beliefs through largely qualitative analyses to determine pathways for change that will be acceptable to both the target culture and conservation goals. In many cases, a lack of interest in raptors and therefore sentiments that are neither negative or positive, can also harm raptors. For example, rock-climbers that approach eagle nests [138], or the use of veterinary medicines or poisons directed against other targets [27,35,135,139], can result in raptor deaths or the abandonment of nests. In such cases, there is a need to develop greater understanding among stakeholders of the requirements for raptor conservation and welfare.

7.3. Supporting Services to Raptor Conservation in the Face of Changing Knowledge and Beliefs (S3–S6 Cases)

Past laws, that persecuted raptors have largely been eliminated, although certain species can be killed in some countries under special licences [24,106,140]. Such laws may have helped develop negative sentiments toward raptors among rural populations with aversions to wildlife-related risks. Changes to these laws were dependent on securing and communicating new knowledge of the true impacts of raptors on livestock and game, and on the conservation status of affected birds [96,141]. The continual accumulation of knowledge concerning raptors will be important to avoid errors in management and to inform stakeholders during decision-making. The communication of accurate information to key stakeholders should be central to conservation efforts [142]. Research for publications, but without popular communications to stakeholders is unlikely to change sentiments that might represent barriers to conservation implementation. Currently a wide array of digital tools is available to better support and communicate research [143,144]. Social networking and online tools can be used to present more positive views of raptors to livestock and game managers that better counter biases in knowledge around potential provisioning services. Furthermore, as indicated by the cases of increased human (farmer)-raptor conflict in Southern Europe following legislation around the disposal of animal carcasses [11,35], researchers must also continue to dialogue with stakeholders and thereby gain insights that facilitate conservation. For example, Bonta et al. [68] indicate how local knowledge of seemingly implausible raptor behaviours can be unduly dismissed by researchers and thereby delay or hinder adaptive ecosystem management practices. A focus on dialogue between stakeholders and an appreciation of the relative strengths and expectations of different stakeholders when implementing management actions is often associated with successful conservation initiatives [66].

7.4. Empathy for Raptors as a Supporting Service to Conservation (S7 Cases)

Cultural and spiritual, non-materialistic values for raptors and other wildlife can be key to conflict resolution [22,26,62,104]. Little research has been conducted in this area [62,145], but such deep-held values are likely to be highly sustainable compared to reform ecology approaches. Indeed, the Millennium Ecosystem Assessment, the Convention on Biological Diversity and related National Biodiversity Strategies and Action Plans tend to encourage a predominantly monetary valuation of ecosystem services [66], which can be counter-productive in some cases, because it does not foment tolerance in the face of ecosystem disservices. Consequently, there is a need to document spiritual and emotional cultural ecosystem services in non-monetary terms to help bridge the gap between non-tangible cultural (dis)services that are important to stakeholders and the more tangible ecosystem
services that are generally used to support conservation policies [10,63]. For example, Dayer et al. [63] describe how the traditional knowledge among an indigenous Mapuche community in Chile that uses owls to predict weather conditions could be incorporated into community actions, including tourism, wildlife monitoring and intergenerational dialogue, to support conservation initiatives. Already, several religious groups are working to enhance environmental and wildlife-conservation sentiments among adherents [145,146]. For example, the Head of the Catholic faith has called on people throughout the world to experience an ‘ecological conversion’ that recognizes the inherent values of species [147].

7.5. Supporting Services to Conservation in the Face of Ill-Will toward Raptors (58 Cases)

Our review of literature clearly indicates that stakeholders that are likely to experience direct provisioning disservices from predatory birds in the form of losses to livestock or game, will in general have negative sentiments toward raptors and their conservation. In such cases, contrary knowledge will have little impact in changing stakeholder opinions because farmers and game managers tend to be highly risk adverse [41,42]. However, conservation practitioners can work with the stakeholders to reduce risks by improving infrastructure to protect chickens and other small animals, by using guard dogs or increasing vigilance, or by allowing tall vegetation to develop where animals can birth their young [24,106,107]. Evidence suggests that perceptions of lower risks to livestock because of such measures will reduce aggression toward the birds [107,148]. However, there is still a need to investigate optimal pest management methods. For example, discrepancies about the effects of diversionary feeding on raptor-livestock interactions [24,25,35] could lead managers to adopt methods that actually increase raptor-related losses. The use of effigies (using real body parts) and practices around hanging dead birds near roosts to deter other raptors [24,149] will have associated negative, and possibly enduring consequences for conservation because these can become expressions of anger among livestock owners and thereby enhance notions of disrespect for the birds. For example, in Mato Grosso (Brazil), Harpy Eagles (Harpia harpyja) are frequently shot as a sport that has been justified by possible past risks of eagle damage to livestock [148,150,151]. Solving problems related to raptor provisioning disservices is an important component in raptor conservation, and regarding it as such requires some education among affected stakeholders toward respect for the target raptor species. Researchers, particularly social scientists, might also work to estimate, together with livestock and game managers, realistic financial losses from raptors based on the managers’ own observations of animal mortalities. Such exercises will often demonstrate to stakeholders the discrepancies between realistic probable losses and exaggerated perceived losses as influenced by the stakeholders’ aversions to risk [43]. Encouraging stakeholders to investigate their own reasons for actions allows that any changes of opinion may come from their own reformed perspectives.

8. Conclusions

Our review of cases indicates that the recognition and documentation of raptor cultural (dis)services, and a linking of such (dis)services to tangible provisioning (dis)services either within or among stakeholder groups can be used to inform conservation practitioners and thereby support implementation. We have indicated, using case studies, that there are recurring service-knowledge-belief patterns related to raptors and that these can result in sometimes predictable outcomes for raptor conservation. Case studies have also indicated links between knowledge, practices and beliefs from different stakeholders, who often have very different appreciations and perceptions of raptors, to either support or counter conservation efforts. Therefore, the application of social science and ethnobiological approaches to the conservation of raptors and other wildlife requires continuing research attention because very often, it is cultural norms, not policy, that ultimately determine the nature of human-raptor interactions in rural and urban landscapes throughout the world.
Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/birds2020014/s1; Table S1: List of papers that include data and observations related to raptor cultural ecosystem services.

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