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ADAPTATION OF IUCN CLASSIFICATION SCHEMES FOR ENVIRONMENTAL SAFETY PASSPORTS OF SPECIES

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Abstract. This study aimed to improve the ways of risk assessment for environmental safety. The implementation of "Environmental safety passports of species" is of practical importance for effective risk assessment of individual species impact to the environment, humans and other living organisms. The classification schemes of International Union for Conservation of Nature for evaluating habitats, threats & stresses, use and trade, livelihoods of species were analyzed and adapted to the requirements of environmental safety. Some sections such as general information about species, their distribution, ecological classification, metabolism features, risks evaluation and beneficial use were itemized to be included into the structure of ESPS.

Keywords: environmental safety, risk assessment, evaluating schemes, certification.

1. Introduction

Problems of environmental safety and nature protection are closely related. However behooves of particular species can be in confrontation with interests of humans, other living organisms and ecosystems [1]. "Environmental safety passports of species" (ESPS) appear to be a universal platform for impersonal evaluating of risk taking into account the interests and tasks of environmental safety and nature protection [2]. ESPS accumulate veracious scientific information about individual species and evaluation of risk probability of real and potential threats from this organism to the environment, humans and other bio-objects [3]. This system will enhance control level of particular species activity and improve the effectiveness of environmental protection [4].

The implementation of ESPS will promote nature conservation, because it will help to discover some risks from individual species for the environment on the one hand, and ground their environmental protection on the other hand. The leader of scientific developments in species protection is International Union for Conservation of Nature (IUCN). This organization was founded in 1948 as the world's first global environmental structure for conserving biodiversity and helps to find pragmatic solutions to most pressing environment and development challenges. It has an official observer status at the United Nations General Assembly and influences international environmental conventions, policies and laws. IUCN is the world's largest global environmental organization with more than 1,200 government and NGO members and almost 11,000 volunteer experts grouped in six commissions in some 160 countries.

IUCN's work focuses on valuing and conserving nature, ensuring effective and equitable governance of its use, and deploying nature-based solutions to global challenges in climate, sustainable development and food security. The central mission of IUCN is to demonstrate that biodiversity is fundamental for solving some of the world's greatest problems. Scientific experts set definite international global standards of species extinction risk assessment for the IUCN Red List of Threatened Species [5]. A set of standard terms has been developed for documenting taxa on the IUCN Red List [6]. These classification schemes ensure global uniformity when describing the habitat in which a taxon occurs, the threats to the species, the conservation actions needed and practical ways of using taxon [7]. The **objective** of this study is adaptation of IUCN classification schemes to ESPS to find the optimum way of risk assessment from biological objects to environmental safety.

2. Analysis of IUCN Classification Schemes for applying in environmental safety

IUCN classification schemes are used and constantly improved by a lot of scientists around the world during a long period. It is a very appropriate platform for applying in environmental safety. The analysis of these schemes is needed for adaptation to the requirements of species certification. The classification schemes used in the Red List IUCN assessments

include: habitats, threats, stresses, conservation actions in place, conservation actions needed, research needed, use and trade, plant growth forms, ecosystem services, livelihoods [8]. All data are accumulated in the Species Information Service (SIS), which is the central database used by IUCN to store and manage species accounts and assessments for publication on the IUCN Red List. SIS allows the user to enter biological, population, range, and habitat information about the species and have the system of automatic calculation of the categories and criteria of the current Red List. It provides a standardized data format for conducting assessments thereby ensuring assessments using the same classification systems (for threats, habitats, etc) as well as ensuring taxonomic integrity. As an online web application, it allows experts to collaborate remotely on assessments and provides safe, secure storage of assessment information. SIS can also be downloaded and used offline when no reliable internet connection is available. The SIS code source is open and free – anyone can take the SIS system and adapt it to their needs. This service even supports entering uncertain information and calculates a range of possible categories based on uncertain information. Some of the main parts of IUCN classification schemes are analyzed below and grouped by environmental safety precedence.

2.1. Habitat

IUCN habitats classification schemes contain 18 main levels: forest & woodland, savanna, shrubland, native grassland, wetlands, inland rocky areas, caves & subterranean habitats, desert, marine – neritic, marine – oceanic, marine – deep ocean floor (benthic and demersal), marine – intertidal, marine – coastal / supratidal, artificial – terrestrial, artificial – aquatic, introduced vegetation, other, unknown [9]. These levels are divided into sublevels with definitions and examples of alternative habitat terms especially those used in different parts of the world. The habitat types are standard terms used to describe the major habitats in which taxa occur. The importance of each habitat recorded is indicated by coding its suitable – the species occurs in the habitat regularly or frequently, marginal – the species occurs in the habitat irregularly or rarely, or only a small proportion of individuals are found in the habitat, and seasonality – resident, breeding, non-breeding, passage, unknown.

2.2. Threats & stresses

Any analysis of the threats should preferably take into account the timing – past, ongoing or future, scope – the proportion of the total population affected, and severity – the overall declines caused by the threat to calculate an impact score. The analysis also shows the threats impact on taxa concerned as recorded by the stresses. Threats are presented by 12 levels of classification: residential & commercial development, agriculture & aquaculture, energy production & mining, transportation & service corridors, biological resource use, human intrusions & disturbance, natural system modifications, invasive & other problematic species (or genes), diseases, pollution, geological events (volcanoes, earthquakes, avalanches), climate change & severe weather, other options. Stresses are those attributes of a taxon that are impaired directly or indirectly by human activities or processes, e.g., reduced population or fragmentation of forest habitat. Stress is not a threat in and of itself, but rather a degraded condition or "symptom" of the taxon that results from a direct threat. Stresses classification scheme is divided into ecosystem or community and species stresses [10].

2.3. Livelihoods, use and trade

This part shows practical use of living organisms: livelihood, economic & other incentives linked with enterprises & livelihood alternatives, substitution, market forces, conservation payments, non-monetary values. In livelihoods classification scheme a separate record should be created for each type of the product. General consumtion details include the scale of use (local, national, regional, global) and description of the product (e.g. skin, meat, horn, fibre, etc.). Annual consumption of the product can be estimated in volume (m^3), weight (kg), number of individuals. Primary the level of human reliance on this product can be evaluated as emergency resource, optional alternative and essential staple, geographically variable. The question should be asked, who the primary consumers of this resource are: men, women, children, multiple, poorer households, all households, richer households, or another groups. To value the livelihoods it is necessary to calculate the proportion (as %) of total population benefiting from this product, the proportion of household consumption of dietary (as a %) protein/carbohydrate and the proportion of household income for this product. An annual cash income from this product is counted [11].

2.4. Conservation activity

This paragraph combines conservation actions in place, conservation actions needed, research needed and ecosystem services. Conservation activity includes habitat & resource management and protection, species management and recovery, education & awareness, law & policy regulations, research, monitoring, planning and other actions. For ecosystem services IUCN proposes to care about water quality & supplies, flood control, climate regulation, landscape, air quality, nutrient cycling, habitat maintenance, provision of critical habitat, pollination, erosion control, bio-control, shoreline protection [12].

3. Results

After the analysis of IUCN classification schemes it was necessary to modify the structure of ESPS using a lot of experience of species evaluation during many years. The main difference between Red List IUCN evaluation and assessment of species for ESPS is in estimation target: in the first case it is necessary to find the reason for protection of species, in the second one – to discover potential or real risks from this species to humans, other living organisms or nature. But in both cases it is necessary to accumulate information about the evaluated species, therefore some elements of IUCN classification schemes can be included to plan the structure of ESPS. As a result the next plan for the main part of species passport scheme is proposed below.

3.1. General information about species includes taxonomical position, morphology, life cycle, etc. ESPS summarize the data of scientific researchers from different fields of science in any accessible way. It will provide the most comprehensive information about different aspects of the species from the reliable sources of information. All available data about each species of living organisms will be conveniently structured in the passport. ESPS will have an open structure for addition of new data obtained by the experts. In this way scientific information becomes available to a wide range of stakeholders which will help to avoid wrong interpretations and enhance the systematization of environmental safety.

3.2. Habitat & geographical distribution

A habitat is the ecological or environmental area where an organism lives, finds food, shelter, protection and mates for reproduction. A habitat is made up of physical factors such as soil, moisture, range of temperature, and availability of light as well as biotic factors. A habitat classification scheme can be defined as a structured system of habitat types, arranged in a hierarchy, where the types are clearly defined and recur in different geographical places. Worldwide, there are many habitat classification schemes and whilst many have a hierarchical structure, others are not hierarchical, providing a structured list of habitat attributes instead. In a hierarchical system habitat classes are described at various levels of detail and are nested so that numerous detailed habitats lay within a smaller number of more broadly-defined habitat classes. It is a guiding principle that classes should recur under similar environmental conditions in other geographical areas to justify their inclusion into a classification system. Habitat description was developed in IUCN classification schemes in a very rational and detailed way, so it is expedient to use this structure with related links [9].

3.3. Ecological classification of species shows the adaptation way of organisms to the environment, their place in nature and types of relationships with other living organisms and human. Functional groups of organisms are based on morphological, physiological, behavioral, biochemical, environmental responses or on trophic criteria. Classification considers ecological role, degree of specialization, trophic level, adaptations and behavior of organisms. There are six main ecological relationships between organisms two of which are oppositional and four are symbiotic. The oppositional relationships are predation and competition. The symbiotic relationships are mutualism, commensalism, amensalism and parasitism. The ecological relationship an organism depends on is the way the organism adapted to its environmental pressures on evolutionary bases. Ecological niche shows the role the organisms play in the ecosystem: producers, consumers, herbivores, carnivores, omnivores, scavengers, decomposers, etc. Interspecific relations are numerous interactions between different species, which are usually described according to their beneficial, detrimental, or neutral effect: for example, mutualism is relation (++), or competition is relation (--). Other interspecific relations include parasitism, infectious disease and competition for limited resources, which can occur when two species share the same ecological niche. Ecological classification also depends on physical and mechanical fields, based on such abiotic factors, as light, temperature, electromagnetic field, radionuclides, noise, etc. The analysis of the impacts of abiotic factors from habitat to species vital activity shows the range of tolerance, optimum, minimum and maximum value of each factor. Geological, geographical, hydrological, atmosphere and climatological parameters are also taken into account.

3.4. Metabolism features discover the role of the species in nutrient cycle; absorbed, released and accumulated substances of this species; bioactive and toxic molecules produced by this organism. Metabolism is a set of life-sustaining chemical transformations within living organisms. The chemical reactions of metabolism are organized into metabolic pathways, in which one chemical is transformed through a series of steps. The metabolic system of a particular organism determines which substances it will find nutritious and which poisonous. Three basic classes of molecules (amino acids, carbohydrates and lipids) are vital for life; metabolic reactions either focus on making these molecules during the construction of cells and tissues, or by breaking them down and using them as a source of energy, by their digestion. Some organisms produce secondary metabolites, which influence the growth, survival, and reproduction of other organisms. These biochemicals are known as allelochemicals and can have

beneficial (positive allelopathy) or detrimental (negative allelopathy) effects on the target organisms. A striking feature of metabolism is the similarity of the basic metabolic pathways and components between even vastly different species. The main metabolic reactions comprise transformation of carbon-containing compounds, transfer of energy from one substrate to another molecular, and oxidation-reduction reactions. If organisms use sunlight as energy source, they are called phototrophic, if organisms preform molecules for energy, they are named chemotrophic. Depending on electron donor there are organotrophic (organic compound) and lithotrophic (inorganic compound). According to carbon source used for the synthesis of organic substances all organisms are divided into heterotrophic (organic compound) and autotrophs (inorganic compound). These three criteria of classification with two variants forming 8 possible combinations exist in nature.

3.5. Risks evaluation

The main purpose of the introduction of passports is to systematize scientific information for determination of effect of the evaluated species on the environment, humans and other living organisms. As a result of the analysis of the information about the evaluated organisms it is be possible to draw a conclusion about the risks and danger impact on this species. The passport calculates statistical probability of negative effects that this species can cause on other organisms, humans and the environment, with specified possible conditions. In Bayesian methods of environmental safety the methodology for risk assessment is perspective for the probability analysis.

3.5.1. Threats for species

Direct threats of proximate human activities or processes that have affected, are affecting, or may affect the status of the species have been assessed. Direct threats are synonymous to the sources of stress and proximate pressures. Threats can be past (historical, unlikely to return or historical, likely to return), ongoing, and/or likely to occur in the future. For each threat additional information may be recorded, some elements of which are required as a part of the minimum documentation standards: timing of the threat (past, ongoing, future, unknown); scope (how much of the species is impacted by the threat) and severity (what is the impact of the threat). The timing, scope and severity are used to calculate an impact score which is useful for the analysis and for distinguishing between major and minor threats. These are threats connected with the area of human intrusion, disturbance and commercial development. It can be urban, industrial, transportation, recreational, agriculture, aquaculture and other activity. This category includes different types of pollution: waste water, effluents, oil spills, seepage from mining, nutrient loads, pesticides, air-borne pollutants (acid rain, smog, ozone) and excess energy pollution (light, thermal, noise). Species can be affected by war, civil unrest, storms, flooding, droughts, volcanoes, earthquakes, tsunamis, avalanches, landslides, climate change and severe weather. Habitat of species can be shifting alteration as a result of natural system modifications. Ecosystem conversion can be realized by degradation and indirect ecosystem effect because of fire, dams, soil erosion, etc. Threats from consumptive use of "wild" biological resources including both deliberate and unintentional harvesting effects: hunting, fishing, gathering, collecting, logging, harvesting. Threats in the class can affect both target species as well as “collateral damage” to non-target species and habitats. Persecution involves harming or killing species because they are considered undesirable [10].

3.5.1. Danger from species

The analysis of species habitats, ecology, distribution and metabolism to find out that these organisms can be really dangerous for the environment, humans and other living organisms has been made. Species can directly affect other organisms’ mortality and disturbance. Also it can be indirect species effect, such as hybridization, competition, inbreeding, loss of mutualism. Species can reduce reproductive success and cause skewed sex ratios, loss of pollinator or other factors which may prevent reproduction of other species. Threats from non-native species or genetic materials have or are predicted to have harmful effects on biodiversity after their occurrence, spread and increase in abundance. Native species can be problematic, when they become superabundant or otherwise cause problems. Harmful organisms not originally found within the ecosystem in question are directly or indirectly introduced and spread into it by human activities. For diseases, it is the infective agent which is considered to be the threat, with the disease being its manifestation in individuals. A number of them are important pathogens which can result in diseases which significantly reduce reproduction or increase mortality. Harmful species originally found within the ecosystem in question, have become “out-of-balance” or “released” directly or indirectly due to human activities. It is a bit of a judgment call as to when a species becomes “problematic”, also referred to as species being "outside its natural range of variation". For diseases it is the infective agent which is considered to be the threat, with the disease being its manifestation in individuals [10].

3.6. Beneficial use

This section applies the paradigm of payments for environmental services (PES), which is a highly promising conservation approach that can improve the resource base over traditional conservation approaches [13]. PES, also known as payments for ecosystem services have been defined as a transparent system for the additional provision of environmental services through conditional payments to voluntary providers. Twenty-four specific ecosystem services were identified and assessed by the Millennium Ecosystem Assessment report in 2005 designed to assess the state of the world's ecosystems. The report defined broad categories of ecosystem services such as food production (in the form of crops, livestock, fisheries, aquaculture, and wild food), fiber (in the form of timber, cotton, hemp, and silk), genetic resources (biochemicals, natural medicines, and pharmaceuticals), fresh water, air quality regulation, climate regulation, water regulation, erosion regulation, water purification & waste treatment, disease regulation, pest regulation, pollination, natural hazard regulation, and cultural services (including spiritual, religious, and aesthetic values, recreation and ecotourism). Notably, there is a "big three" among these 24 services which are currently receiving most interest worldwide: these are climate change mitigation, watershed services and biodiversity conservation [13]. In analogy (reciprocally) the system of evaluation for species services will be developed for ESPS. It can be useful for assessment of beneficial use of any living organisms for human and their significance for nature.

4. Discussion

IUCN classification schemes contain many utility specifications which can be used for the developing structure of ESPS. Adaptation of these schemes is itemized in ESPS structure in such sections as general information about species, habitat & geographical distribution, ecological classification, metabolism features, risks evaluation and beneficial use. Passport systematizes scientific information for determination of the effect of this species on the environment, humans and other living organisms. On the other hand, threats for this species from other species, people and different ecological factors could be evaluated with this passport. ESPS are necessary for effective monitoring and management of environmental safety. Implementation of species certification will increase the level of control in the system of ecological safety and effectiveness of protection actions for environment and humans. It is a comprehensive document which is necessary for all species of living organisms. This minimizes the possibility of incorrect interpretation of scientific data and creates the conditions for constructive interaction between scientists and managers. Work in this direction can help to carry out "The Strategic Plan for Biodiversity 2011–2020", which includes the values of biodiversity and further develops or enhances the systems for integrating biodiversity values into decision making processes [14]. Global-extent, high-resolution analyses using broad biodiversity and anthropogenic data are needed in order to inform about decision making within the Convention on Biological Diversity resolutions [12]. Some basic methodologies do exist which can serve as a starting point for further monitoring or provide baseline information. The resulting information should be integrated into development plans to ensure that some species receive necessary protection and investments. Such system could help to plan preventive measures for protection from dangerous species. It is important that the results of such analysis are made publicly available and easy to access, so that they can be further utilized, evaluated, and improved. ESPS are necessary for effective monitoring and management of environmental safety. Implementation of species certification will increase the level of control in the system of ecological safety and effectiveness of protection actions for the environment and the humans.

5. Conclusions

1. The bases platform of ESPS structure was improved as a result of IUCN classification schemes analysis for evaluating features and abilities of certain species for the relevant requirements of environmental safety.

2. The adapted ESPS content includes two main parts: the fist section accumulates general information about species, its taxonomy, morphology, life cycle, ecological classification, habitats, distribution, metabolism features, nutrient cycle, bioactive and toxic molecules, etc.; the second part provides evaluation of impact risks to this species and danger effects of this species, considering the beneficial human and environmental use.

3. ESPS contributes to nature protection by discovering some risks from individual species to environment, and at the same time this passport provides the background for conservation of the estimated species by assessment of threats to them.

4. The analyzed methodologies of payments for environmental services can be transformed into the system of evaluation for human use of certain species and environmental services by any living organisms and assess of their significance for nature and people.

5. The implementation of Environmental safety passports of species can forward "The Strategic Plan for Biodiversity 2011–2020", to develop and enhances systems for integrating biodiversity values into decision making processes.

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