Contributed Paper

A Standard Lexicon for Biodiversity Conservation: Unified Classifications of Threats and Actions

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Abstract: *An essential foundation of any science is a standard lexicon. Any given conservation project can be described in terms of the biodiversity targets, direct threats, contributing factors at the project site, and the conservation actions that the project team is employing to change the situation. These common elements can be linked in a causal chain, which represents a theory of change about how the conservation actions are intended to bring about desired project outcomes. If project teams want to describe and share their work and learn from one another, they need a standard and precise lexicon to specifically describe each node along this chain. To date, there have been several independent efforts to develop standard classifications for the direct threats that affect biodiversity and the conservation actions required to counteract these threats. Recognizing that it is far more effective to have only one accepted global scheme, we merged these separate efforts into unified classifications of threats and actions, which we present here. Each classification is a hierarchical listing of terms and associated definitions. The classifications are comprehensive and exclusive at the upper levels of the hierarchy, expandable at the lower levels, and simple, consistent, and scalable at all levels. We tested these classifications by applying them post hoc to 1191 threatened bird species and 737 conservation projects. Almost all threats and actions could be assigned to the new classification systems, save for some cases lacking detailed information. Furthermore, the new classification systems provided an improved way of analyzing and comparing information across projects when compared with earlier systems. We believe that widespread adoption of these classifications will help practitioners more systematically identify threats and appropriate actions, managers to more efficiently set priorities and allocate resources, and most important, facilitate cross-project learning and the development of a systematic science of conservation.*

Keywords: actions taxonomy, authority files, Conservation Measures Partnership, conservation science, conservation strategies, direct threats to biodiversity, IUCN Red List, threats taxonomy

Un Lexicón Estándar para la Conservación de Biodiversidad: Clasificaciones Unificadas de Amenazas y Acciones

Resumen: *Un fundamento esencial de cualquier ciencia es un lexicón estándar. Cualquier proyecto de conservación puede ser descrito en términos de los objetivos de biodiversidad, directas amenazas, factores subyacentes en el sitio del proyecto y las acciones de conservación que el equipo está empleando para cambiar la situación. Estos elementos comunes se pueden eslabonar en una cadena causal, que representa una teoría de cambio de cómo las acciones de conservación alcanzarán los resultados deseados. Si los equipos de los*

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proyectos quieren describir y compartir su trabajo y aprender uno de otro, se requiere un lexicón estándar y preciso para describir específicamente cada nodo a lo largo de esta cadena. A la fecha, ha habido varios esfuerzos independientes para desarrollar clasificaciones estándar para las amenazas directas que afectan la biodiversidad y las acciones de conservación requeridas para contrarrestar estas amenazas. Reconociendo que es mucho más efectivo tener solo un esquema global aceptado, combinamos estos esfuerzos separados en clasificaciones unificadas de amenazas y acciones, que presentamos aquí. Cada clasificación es un listado jerárquico de términos y definiciones asociadas. Las clasificaciones son integrales y exclusivas de los niveles superiores de la jerarquía, expandibles en los niveles inferiores y simples, consistentes y escalables en todos los niveles. Probamos estas clasificaciones aplicándolas post hoc a 1191 especies amenazadas de aves y 737 proyectos de conservación. Casi todas las amenazas y acciones podrían ser asignadas a los nuevos sistemas de clasificación, salvo algunos casos que carecen de información detallada. Más aun, los nuevos sistemas de clasificación proporcionaron una mejor manera de analizar y comparar información en proyectos cuando son comparados con sistemas previos. Consideramos que la adopción generalizada de estas clasificaciones ayudará que practicantes identifiquen amenazas y acciones apropiadas más sistemáticamente, manejadores definan prioridades y asignen recursos más eficientemente y, más importante, facilitar el aprendizaje y el desarrollo de una ciencia de la conservación sistemática.

Palabras Clave: amenazas directas a la biodiversidad, archivos de autoridad, Asociación de Medidas para la Conservación, ciencia de la conservación, estrategias de conservación, Lista Roja IUCN, taxonomía de amenazas

Introduction

Nomenclature as the Foundation of Any Science

There is a growing desire to improve information sharing and learning among conservation practitioners within and across organizations (e.g., Salafsky et al. 2002; Sutherland et al. 2004; Pullin & Stewart 2006). Ultimately, these efforts seek to develop a body of knowledge and best practices—to create a systematic science of biodiversity conservation.

An essential foundation of any science is a standard lexicon—the equivalent of Linnaeus's classification system for living organisms in biology, Mendeleev's periodic table of the elements in chemistry, or the formal terms that medical researchers and practitioners use to describe human ailments and potential treatments. The same is true for conservation science; its practitioners also need a common language to talk about the problems and potential solutions that they encounter. This common language would enable front-line conservationists to identify threats and potential actions to counter them at their sites, and managers and decision makers to assess the frequency of threats and actions at various scales to help set priorities and allocate resources. More important, it would enable conservationists around the world to share and exchange experiences through common databases of conservation practice, thus facilitating cross-project learning and the development of principles about what actions are effective under different conditions to counter different threats.

Framework and Key Definitions

Conservation work ultimately takes place through projects. A project can be generally defined as "any set of actions undertaken by a group of people and/or organizations to achieve defined [biodiversity conservation] goals and objectives" (Salafsky et al. 2002). Conservation projects can range in scale from efforts by a local community to protect a small sacred grove to a global funding program to protect the world's oceans. Building on a review of terms used by different conservation practitioners (Salafsky et al. 2003), we propose the following general definitions to describe the general components of any given conservation project (Fig. 1).

- Biodiversity targets: The biological entities (species, communities, or ecosystems) that a project is trying to conserve (e.g., a population of a specific species of fish or a forest ecosystem). Some practitioners also include ecological and evolutionary phenomena and processes as targets. Biodiversity targets are synonymous with *focal conservation targets* and *biodiversity features.*
- Stresses: Attributes of a conservation target's ecology that are impaired directly or indirectly by human activities (e.g., reduced population size or fragmentation of forest habitat). A stress is not a threat in and of itself, but rather a degraded condition or "symptom" of the target that results from a direct threat. Stresses are synonymous with *degraded key attributes*.
- Direct threats: The proximate human activities or processes that have caused, are causing, or may cause the destruction, degradation, and/or impairment of biodiversity targets (e.g., unsustainable fishing or logging). Direct threats are synonymous with *sources of stress* and *proximate pressures*. Threats can be past (historical), ongoing, and/or likely to occur in the future. As discussed later, natural phenomena are also regarded as direct threats in some situations.
- Contributing factors: The ultimate factors, usually social, economic, political, institutional, or cultural, that enable or otherwise add to the occurrence or persistence of proximate direct threats. There is typically

Figure 1. A general model of a conservation project. Conservation actions can be applied to contributing factors, direct threats, or even to biodiversity targets as indicated by the box around these factors. See text for definitions.

a chain of contributing factors behind any given direct threat. In a situation analysis, these factors are often subdivided into indirect threats (factors with a negative effect, such as market demand for fish) and opportunities (factors with a positive effect, such as a country's land-use planning system that favors conservation). Contributing factors are synonymous with *underlying factors, drivers*, or *root causes.*

- Conservation actions: Interventions undertaken by project staff or partners designed to reach the project's objectives and ultimate conservation goals (e.g., establishing an ecotourism business or setting up a protected area). Actions can be applied to contributing factors, direct threats, or directly to the targets themselves (Fig. 1). Conservation actions are roughly synonymous with *strategies, interventions, activities, responses,* and *measures* (in the action sense, not the monitoring sense).
- Project teams: The groups of people involved in designing, implementing, managing, and monitoring projects (e.g., a partnership between a local nongovernmental organization and a community or the staff of a national park).

Any given conservation project can be described or modeled by one or more specific "chains" linking the specific targets, threats, and contributing factors at the project site and the actions that the project team is employing to change this situation. In effect, these chains lay out the assumed theory of change behind the project. If project teams want to describe and share their work, they need a standard and precise lexicon to specifically describe each node along this chain.

Species-based biodiversity targets can already be classified on the basis of the Linnaean system. Habitat-based targets are the subject of a global classification scheme currently under development (IUCN 2006). For direct threats and conservation actions, there have been several independent efforts to develop classification schemes (e.g., Salafsky et al. 2002; CMP 2004; IUCN 2005*a*, 2005*b*). Recognizing that it is far more effective to have only one accepted global scheme, we merged these separate efforts into the unified classifications presented here. A remaining gap is the classification of contributing factors, which is a difficult undertaking because these potentially include an extremely broad suite of possibilities.

Classification Development

The immediate parents of the classifications described here are the schemes developed by the Conservation Measures Partnership (CMP 2005) and the IUCN Species Survival Commission (IUCN 2005*a*, 2005*b*). These schemes were developed independently of one another, and although they share some basic similarities, they also have key differences. Given the importance of having a single global scheme, we set out to merge the 2 efforts.

An ideal classification for both threats and actions would be simple (uses clear language and examples and is understandable by all practitioners); hierarchical (creates a logical way of grouping items that are related to one another to facilitate use of the classification and meaningful analyses at different levels); comprehensive (contains all possible items, at least at higher levels of the hierarchy; consistent (ensures that entries at a given level of the classification are of the same type); expandable (enables new items to be added to the classification if they are discovered); exclusive (allows any given item to only be placed in one cell within the hierarchy); and scalable (permits the same terms to be used at all geographic scales).

We took the best elements of each parent classification and through lengthy discussions and testing with actual project data, created draft unified classifications in March 2006. We tested these classifications by applying them to a wide range of conservation projects to ensure that they met the above criteria when applied to real-world data. Feedback from reviewers and from the extensive application of the draft classifications led to further revisions and the release of version 1.0 of the Unified Classifications for Threats and Actions in June 2006. These drafts were sent out for additional comment and testing with a wide range of projects and practitioners. We then revised the classifications through an iterative process. This process resulted in version 1.1, which we present here.

Unified Classifications of Threats and Conservation Actions

The unified direct-threats classification (Table 1) and the conservation-actions classification (Table 2) are each constructed in a hierarchical fashion with 3 different levels (the equivalent of families, genera, and species in

Table 1. World Conservation Union–Conservation Measures Partnership (IUCN-CMP) classification of direct threats to biodiversity (version 1.1).

Threats by level of classification[a] (1st and 2nd levels comprehensive; 3rd levels examples only)	*Definition[b]*
1. Residential and commercial development	**human settlements or other nonagricultural land uses with a substantial footprint**
1.1 housing and urban areas	human cities, towns, and settlements including nonhousing development typically integrated with housing
urban areas, suburbs, villages, vacation homes, shopping areas, offices, schools, hospitals	
1.2 commercial and industrial areas	factories and other commercial centers
manufacturing plants, shopping centers, office parks, military bases, power plants, train and ship yards, airports	
1.3 tourism and recreation areas	tourism and recreation sites with a substantial footprint
ski areas, golf courses, beach resorts, cricket fields, county parks, campgrounds	
2. Agriculture and aquaculture	**threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture, and aquaculture**
2.1 annual and perennial nontimber crops	crops planted for food, fodder, fiber, fuel, or other uses
farms, household swidden plots, plantations, orchards, vineyards, mixed agroforestry systems	
2.2 wood and pulp plantations	stands of trees planted for timber or fiber outside of natural forests, often with non-native species
teak or eucalyptus plantations, silviculture, christmas tree farms	
2.3 livestock farming and ranching	domestic terrestrial animals raised in one location on farmed or nonlocal resources (farming); also domestic or semidomesticated animals allowed to roam in the wild and supported by natural habitats (ranching)
cattle feed lots, dairy farms, cattle ranching, chicken farms, goat, camel, or yak herding	
2.4 marine and freshwater aquaculture	aquatic animals raised in one location on farmed or nonlocal resources; also hatchery fish allowed to roam in the wild
shrimp or fin fish aquaculture, fish ponds on farms, hatchery salmon, seeded shellfish beds, artificial algal beds	
3. Energy production and mining	**threats from production of nonbiological resources**
3.1 oil and gas drilling	exploring for, developing, and producing petroleum and other liquid hydrocarbons
oil wells, deep sea natural gas drilling	
3.2 mining and quarrying	exploring for, developing, and producing minerals and rocks
coal mines, alluvial gold panning, gold mines, rock quarries, coral mining, deep sea nodules, guano harvesting	
3.3 renewable energy	exploring, developing, and producing renewable energy
geothermal power production, solar farms, wind farms (including birds flying into windmills), tidal farms	
4. Transportation and service corridors	**threats from long, narrow transport corridors and the vehicles that use them including associated wildlife mortality**
4.1 roads and railroads	surface transport on roadways and dedicated tracks
highways, secondary roads, logging roads, bridges and causeways, road kill, fencing associated with roads, railroads	
4.2 utility and service lines	transport of energy and resources
electrical and phone wires, aqueducts, oil and gas pipelines, electrocution of wildlife	
4.3 shipping lanes	transport on and in freshwater and ocean waterways
dredging, canals, shipping lanes, ships running into whales, wakes from cargo ships	
4.4 flight paths	air and space transport
flight paths, jets impacting birds	

continued

Table 1. (continued)

5. Biological resource use	**threats from consumptive use of "wild" biological resources including deliberate and unintentional harvesting effects; also persecution or control of specific species**
5.1 hunting and collecting terrestrial animals	killing or trapping terrestrial wild animals or animal products for commercial, recreation, subsistence, research or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch
bushmeat hunting, trophy hunting, fur trapping, insect collecting, honey or bird nest hunting, predator control, pest control, persecution	
5.2 gathering terrestrial plants	harvesting plants, fungi, and other nontimber/nonanimal products for commercial, recreation, subsistence, research or cultural purposes, or for control reasons
wild mushrooms, forage for stall fed animals, orchids, rattan, control of host plants to combat timber diseases	
5.3 logging and wood harvesting	harvesting trees and other woody vegetation for timber, fiber, or fuel
clear cutting of hardwoods, selective commercial logging of ironwood, pulp operations, fuel wood collection, charcoal production	
5.4 fishing and harvesting aquatic resources	harvesting aquatic wild animals or plants for commercial, recreation, subsistence, research, or cultural purposes, or for control/persecution reasons; includes accidental mortality/bycatch
trawling, blast fishing, spear fishing, shellfish harvesting, whaling, seal hunting, turtle egg collection, live coral collection, seaweed collection	
6. Human intrusions and disturbance	**threats from human activities that alter, destroy and disturb habitats and species associated with nonconsumptive uses of biological resources**
6.1 recreational activities	people spending time in nature or traveling in vehicles outside of established transport corridors, usually for recreational reasons
off-road vehicles, motorboats, jet-skis, snowmobiles, ultralight planes, dive boats, whale watching, mountain bikes, hikers, birdwatchers, skiers, pets in rec areas, temporary campsites, caving, rock-climbing	
6.2 war, civil unrest and military exercises	actions by formal or paramilitary forces without a permanent footprint
armed conflict, mine fields, tanks and other military vehicles, training exercises and ranges, defoliation, munitions testing	
6.3 work and other activities	people spending time in or traveling in natural environments for reasons other than recreation or military activities
law enforcement, drug smugglers, illegal immigrants, species research, vandalism	
7. Natural system modifications	**threats from actions that convert or degrade habitat in service of "managing" natural or seminatural systems, often to improve human welfare**
7.1 fire and fire suppression	suppression or increase in fire frequency and/or intensity outside of its natural range of variation
fire suppression to protect homes, inappropriate fire management, escaped agricultural fires, arson, campfires, fires for hunting	
7.2 dams and water management/use	changing water flow patterns from their natural range of variation either deliberately or as a result of other activities
dam construction, dam operations, sediment control, change in salt regime, wetland filling for mosquito control, levees and dikes, surface water diversion, groundwater pumping, channelization, artificial lakes	
7.3 other ecosystem modifications	other actions that convert or degrade habitat in service of "managing" natural systems to improve human welfare

continued

Table 1. (continued)

land reclamation projects, abandonment of managed lands, rip-rap along shoreline, mowing grass, tree thinning in parks, beach construction, removal of snags from streams	
8. Invasive and other problematic species and genes	**threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance**
8.1 invasive non-native/alien species	harmful plants, animals, pathogens and other microbes not originally found within the ecosystem(s) in question and directly or indirectly introduced and spread into it by human activities
feral cattle, household pets, zebra mussels, Dutch elm disease or chestnut blight, Miconia tree, introduction of species for biocontrol, Chytrid fungus affecting amphibians outside of Africa	
8.2 problematic native species	harmful plants, animals, or pathogens and other microbes that are originally found within the ecosystem(s) in question, but have become "out of balance" or "released" directly or indirectly due to human activities
overabundant native deer, overabundant algae due to loss of native grazing fish, native plants that hybridize with other plants, plague affecting rodents	
8.3 introduced genetic material	Human-altered or transported organisms or genes
pesticide resistant crops, hatchery salmon, restoration projects using nonlocal seed stock, genetically modified insects for biocontrol, genetically modified trees, genetically modified salmon	
9. Pollution	**threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources**
9.1 household sewage and urban waste water	water-borne sewage and nonpoint runoff from housing and urban areas that include nutrients, toxic chemicals and/or sediments
discharge from municipal waste treatment plants, leaking septic systems, untreated sewage, outhouses, oil or sediment from roads, fertilizers and pesticides from lawns and golf-courses, road salt	
9.2 industrial and military effluents	water-borne pollutants from industrial and military sources including mining, energy production, and other resource extraction industries that include nutrients, toxic chemicals and/or sediments
toxic chemicals from factories, illegal dumping of chemicals, mine tailings, arsenic from gold mining, leakage from fuel tanks, PCBs in river sediments	
9.3 agricultural and forestry effluents	water-borne pollutants from agricultural, silivicultural, and aquaculture systems that include nutrients, toxic chemicals and/or sediments including the effects of these pollutants on the site where they are applied
nutrient loading from fertilizer runoff, herbicide runoff, manure from feedlots, nutrients from aquaculture, soil erosion	
9.4 garbage and solid waste	rubbish and other solid materials including those that entangle wildlife
municipal waste, litter from cars, flotsam and jetsam from recreational boats, waste that entangles wildlife, construction debris	
9.5 air-borne pollutants	atmospheric pollutants from point and nonpoint sources
acid rain, smog from vehicle emissions, excess nitrogen deposition, radioactive fallout, wind dispersion of pollutants or sediments, smoke from forest fires or wood stoves	

continued

Table 1. (continued)

9.6 excess energy *noise from highways or airplanes, sonar from submarines that disturbs whales, heated water from power plants, lamps attracting insects, beach lights disorienting turtles, atmospheric radiation from ozone holes*	inputs of heat, sound, or light that disturb wildlife or ecosystems
10. Geological events	**threats from catastrophic geological events**
10.1 volcanoes *eruptions, emissions of volcanic gasses*	volcanic events
10.2 earthquakes/tsunamis *earthquakes, tsunamis*	earthquakes and associated events
10.3 avalanches/landslides *avalanches, landslides, mudslides*	avalanches or landslides
11. Climate change and severe weather	**long-term climatic changes that may be linked to global warming and other severe climatic or weather events outside the natural range of variation that could wipe out a vulnerable species or habitat**
11.1 habitat shifting and alteration *sea-level rise, desertification, tundra thawing, coral bleaching*	major changes in habitat composition and location
11.2 droughts *severe lack of rain, loss of surface water sources*	periods in which rainfall falls below the normal range of variation
11.3 temperature extremes *heat waves, cold spells, oceanic temperature changes, disappearance of glaciers/sea ice*	periods in which temperatures exceed or go below the normal range of variation
11.4 storms and flooding *thunderstorms, tropical storms, hurricanes, cyclones, tornados, hailstorms, ice storms or blizzards, dust storms, erosion of beaches during storms*	extreme precipitation and/or wind events or major shifts in seasonality of storms

[a] *The classification is composed of 3 levels of direct threats, analogous to families, genera, and species in the Linnaean system. The first level is denoted by whole numbers and bold text (e.g.,* ***1. Residential and commercial development)****. The second level is denoted by decimal numbers and roman text (e.g., 1.2 commercial and industrial areas). The third level is denoted by italic text (e.g., manufacturing plants). The classifications are designed to be comprehensive, consistent, and exclusive for the first and second levels. The third level, by contrast, currently contains only some illustrative examples rather than comprehensive listings of threats at this level.*
[b] *Definitions are only given for first and second-level threat classifications.*

the Linnaean system). Each first-level entry (e.g., threat [1] residential and commercial development) is subdivided into several second-level entries (e.g., threat [1.1] housing and urban areas, [1.2] commercial and industrial areas, and [1.3] tourism and recreation areas), and these are in turn subdivided into numerous third-level entries. The classifications are designed to be comprehensive, consistent, and exclusive for the first and second levels. The third level, by contrast, is at a much finer scale and thus only contains some illustrative examples rather than comprehensive listings of threats and actions at this level. Eventually, however, we hope to create comprehensive classifications at the third level and beyond.

The application of an artificial classification system to the real world inevitably requires making subtle distinctions between related categories. Additional exposition and instructions for applying the classifications to these gray areas is available from www.iucn.org/themes/ssc/redlists/classification.htm. For example, under the direct-threat entry (1.2) commercial and industrial areas, the exposition states "Shipyards and airports fall into this category, whereas shipping lanes and flight paths fall under (4) transportation & service corridors. Dams are NOT included here, rather they are in (7.2) dams & water management/use." The Web site also provides an opportunity to provide comments and feedback.

Issues Regarding the Classifications

Natural Phenomena as Threats

For the most part, direct threats are limited to human activities that can be countered with appropriate actions. There is a fine line, however, between a naturally occurring event such as a fire set by lightning (which may be part of a necessary disturbance regime) and a human-caused threat such as a fire set by a match or increased intensity of fires due to forest management practices.

Table 2. World Conservation Union–Conservation Measures Partnership (IUCN-CMP) classification of conservation actions (version 1.1).

Actions by level of classification[a] (1st and 2nd levels comprehensive; 3rd level examples only)	*Definition[b]*
1. Land/water protection	**actions to identify, establish or expand parks and other legally protected areas, and to protect resource rights**
1.1 site/area protection	establishing or expanding public or private parks, reserves, and other protected areas roughly equivalent to IUCN categories I-VI
national parks, town wildlife sanctuaries, private reserves, tribally owned hunting grounds	
1.2 resource and habitat protection	establishing protection or easements of some specific aspect of the resource on public or private lands outside of IUCN categories I-VI
easements, development rights, water rights, instream flow rights, wild and scenic river designation, securing resource rights	
2. Land/water management	**actions directed at conserving or restoring sites, habitats and the wider environment**
2.1 site/area management	management of protected areas and other resource lands for conservation
site design, demarcating borders, putting up fences, training park staff, control of poachers	
2.2 invasive/problematic species control	eradicating, controlling and/or preventing invasive and/or other problematic plants, animals, and pathogens
cutting vines off trees, preventing ballast water discharge	
2.3 habitat and natural process restoration	enhancing degraded or restoring missing habitats and ecosystem functions; dealing with pollution
creating forest corridors, prairie re-creation, riparian tree plantings, coral reef restoration, proscribed burns, breaching levees, dam removal, fish ladders, liming acid lakes, cleaning up oil spills	
3. Species management	**actions directed at managing or restoring species, focused on the species of concern itself**
3.1 species management	managing specific plant and animal populations of concern
harvest management of wild mushrooms, culling buffalo to keep population size within park carrying capacity, controlling fishing effort	
3.2 species recovery	manipulating, enhancing or restoring specific plant and animal populations, vaccination programs
manual pollination of trees, artificial nesting boxes, clutch manipulation, supplementary feeding, disease/parasite management	
3.3 species reintroduction	reintroducing species to places where they formally occurred or benign introductions
reintroduction of wolves	
3.4 *ex situ* conservation	protecting biodiversity out of its native habitats
captive breeding, artificial propagation, gene banking	
4. Education and awareness	**actions directed at people to improve understanding and skills, and influence behavior**
4.1 formal education	enhancing knowledge and skills of students in a formal degree program
public schools, colleges and universities, continuing education	
4.2 training	enhancing knowledge, skills and information exchange for practitioners, stakeholders, and other relevant individuals in structured settings outside of degree programs
monitoring workshops or training courses in reserve design for park managers, learning networks or writing how-to manuals for project managers, stakeholder education on specific issues	

continued

Table 2. (continued)

4.3 awareness and communications	raising environmental awareness and providing information through various media or through civil disobedience
radio soap operas, environmental publishing, Web blogs, puppet shows, door-to-door canvassing, tree sitting, protest marches	
5. Law and policy	**actions to develop, change, influence, and help implement formal legislation, regulations, and voluntary standards**
5.1 legislation	making, implementing, changing, influencing, or providing input into formal government sector legislation or polices at all levels: international, national, state/provincial, local, tribal
global: promoting conventions on biodiversity, wildlife trade laws like CITES National: work for or against government laws such as the US Endangered Species Act, influencing legislative appropriations State/Provincial: state ballot initiatives, providing data to state policy makers, developing pollution permitting systems, dam relicensing Local: developing zoning regulations, countryside laws, species protection laws, hunting bans Tribal: creating tribal laws	
5.2 policies and regulations	making, implementing, changing, influencing, or providing input into policies and regulations affecting the implementation of laws at all levels: international, national, state/provincial, local/community, tribal
input into agency plans regulating certain species or resources, working with local governments or communities to implement zoning regulations, promoting sustainable harvest on state forest lands	
5.3 private sector standards and codes	setting, implementing, changing, influencing, or providing input into voluntary standards and professional codes that govern private sector practice
Marine and Forest Stewardship Councils, Conservation Measures Partnership (CMP) Open Standards, corporate adoption of forestry best management practices, sustainable grazing by a rancher	
5.4 compliance and enforcement	monitoring and enforcing compliance with laws, policies and regulations, and standards and codes at all levels
water quality standard monitoring, initiating criminal and civil litigation	
6. Livelihood, economic and other incentives	**actions to use economic and other incentives to influence behavior**
6.1 linked enterprises and livelihood alternatives	developing enterprises that directly depend on the maintenance of natural resources or provide substitute livelihoods as a means of changing behaviors and attitudes
ecotourism, nontimber forest product harvesting, harvesting wild salmon to create value for wild population	
6.2 substitution	promoting alternative products and services that substitute for environmentally damaging ones
Viagra for rhino horn, farmed salmon as a replacement for pressure on wild populations, promoting recycling and use of recycled materials	
6.3 market forces	using market mechanisms to change behaviors and attitudes
certification, positive incentives, boycotts, negative incentives, grass and forest banking, valuation of ecosystem services such as flood control	
6.4 conservation payments	using direct or indirect payments to change behaviors and attitudes
quid-pro-quo performance payments, resource tenure incentives	

continued

Table 2. (continued)

6.5 nonmonetary values *spiritual, cultural, links to human health*	using intangible values to change behaviors and attitudes
7. External capacity building	**actions to build the infrastructure to do better conservation**
7.1 institutional and civil society development *creating new local land trusts, providing circuit riders to help develop organizational capacity*	creating or providing nonfinancial support and capacity building for nonprofits, government agencies, communities, and for-profits
7.2 alliance and partnership development *country networks, Conservation Measures Partnership (CMP)*	forming and facilitating partnerships, alliances, and networks of organizations
7.3 conservation finance *private foundations, debt-for-nature swaps*	raising and providing funds for conservation work

[a]*The classification is composed of 3 levels of conservation actions, analogous to families, genera, and species in the Linnaean system. The first level is denoted by whole numbers and bold text (e.g.,* ***1. Land/water protection)****. The second level is denoted by decimal numbers and plain text (e.g., 1.2 resource and habitat protection). The third level is denoted by italic text (e.g., easements). The classifications are designed to be comprehensive, consistent, and exclusive for the first and second levels. The third level, by contrast, currently only contains some illustrative examples rather than comprehensive listings of conservation actions at this level.*
[b]*Definitions are only given for first- and second-level action classifications.*

In general, the first one is part of the natural disturbance regime and therefore not a threat, whereas the latter ones are clearly threats.

If, however, a tsunami or forest fires set by lightning would potentially affect one of the last populations of a particular species, then one would have to regard these as threats to the species. Following this logic, we also included geological events, climate change, and severe weather in our classification of direct threats. When humans put pressure on species and ecosystems, the effects of natural events such as tropical storms and volcanoes can be more detrimental than they would otherwise be and should be considered threats in some situations. Anthropologically driven climate change can be either a direct threat itself or an underlying factor behind increases in severe weather. And likewise, native species can be problematic when they become "out of balance" or "released" due to human activities.

Direct Threats versus Stresses

Some systems of threat analysis, such as The Nature Conservancy's Conservation Action Planning Framework (TNC 2006) or the U.S. Environmental Protection Agency's Risk Assessment Framework (EPA 1998), draw a distinction between a source of stress (equivalent to a direct threat) and the stress on the target. As described earlier, a stress is an impaired attribute of a conservation target's ecology that results directly or indirectly from human activities (e.g., reduced population size, impaired reproductive success, fragmented habitat, or degraded water quality). Often a stress exists when the ecological attribute is outside its natural range of variation (TNC 2006). A stress is not a threat in and of itself. Instead, it is a degraded condition of the target that results from a direct threat (Fig. 1).

In the direct-threats classification we tried to exclude stresses and focus only on direct threats (Table 3 provides a high-level classification of stresses for those who might be interested in recording them). For example, within (7) natural system modifications, we included the human activity "fire suppression" rather than the stress "lack of fire." In a few cases, however—most notably (8) invasive & other problematic species and genes; (9) pollution; and (11) climate change and severe weather—the distinction between a direct threat and the resulting stress is more ambiguous. We included them, however, as direct threats because sources of invasive species, pollutants, and severe weather are often unknown, historical, or complex, and in some situations, these species or pollutants can be considered direct threats.

Direct Threats versus Indirect Threats

Excluding indirect threats (contributing factors with a negative effect) from the direct-threats classification is difficult because the line between a direct threat and an indirect threat is not always clear and can be situation-dependent. For example, consider a case in which a chemical factory is being constructed in a wetland habitat. In this situation the chemical factory is the direct threat causing habitat loss. But if an existing chemical factory is discharging heavy metals into the wetland, is the direct threat the factory itself? Or is the direct threat the heavy metals being discharged into the environment, thus making the factory itself an indirect threat? As a general rule, the most proximate factor to the target should become the direct threat and the less proximate threats should be regarded as contributing factors. This means, however, that a factor that is a direct threat in one situation may be considered an indirect threat in another. This issue seems to surface most often

Table 3. World Conservation Union–Conservation Measures Partnership (IUCN-CMP) classification of stresses (version 1.1).[a]

Stresses by Level of Classification[b] (1st and 2nd levels comprehensive; 3rd level examples only)	*Definition[c]*
1. Ecosystem/community stresses	**stresses that affect ecosystems and communities**
1.1 ecosystem conversion	direct and complete conversion of the ecosystem
clear cutting or flooding forest; eliminating a stream; removing a coral reef	
1.2 ecosystem degradation	direct damage to an ecosystem's biotic and/or abiotic biological condition
selective removal of species; removal of top predators; altered fire or hydrological regime	
1.3 indirect ecosystem effects	indirect damage to an ecosystem.
fragmentation or isolation of an ecosystem	
2. Species stresses	**stresses that affect specific species or guilds/groups of species**
2.1 species mortality	direct killing or capturing of species
intentional or accidental killing of species	
2.2 species disturbance	direct damage to a species
disruption of critical lifecycle stages	
2.3 indirect species effects	indirect damage to a species
inbreeding, loss of pollinator or host, increased competition, loss of mutualism	

[a]A stress is a degraded condition of the target that results from a direct threat. See text for details.
*[b]The classification is composed of 3 levels of stresses. The first level is denoted by whole numbers and bold text (e.g., **[1.] Ecosystem/community stresses)**. The second level is denoted by decimal numbers and plain text (e.g., [1.2] ecosystem degradation). The third level is denoted by italic text (e.g., removal of top predators). The classifications are designed to be comprehensive, consistent, and exclusive for the first and second levels. The third level, by contrast, currently only contains some illustrative examples rather than comprehensive listings of stresses at this level.*
[c]Definitions are only given for first- and second-level stress classifications.

when dealing with pollution threats. In these cases, it is helpful to record both the pollutant and the source of the pollution in a text description of the direct threat.

Defining Conservation Actions

The work of most conservation practitioners can be subdivided into 2 main classes: general management actions and project-specific conservation actions. General management actions are steps that need to be undertaken by every conservation project or program and include setting priorities, developing a situation analysis, designing and implementing a strategic plan, developing and implementing a monitoring plan, and analyzing and communicating results (CMP 2004). They also include fundraising, reporting, administrative work, and developing and managing the institutions with which the project or program is affiliated. Project-specific conservation actions, by contrast, are specific interventions taken by a project team to counter threats to biodiversity, take advantage of opportunities, or restore degraded biodiversity targets. The selection of these actions varies depending on the conditions faced by each project team.

Although both types of actions are important, they are also conceptually distinct from one another and thus cannot be placed in the same classification system. The conservation-actions classification thus only includes the project-specific conservation actions, whereas the general management actions are summarized in the Conservation Measures Partnership's *Open Standards for the Practice of Conservation* (CMP 2004).

Disaggregating Actions from Objectives and Actors

Any given conservation activity can be disaggregated into several components: objectives (what the activity is trying to accomplish), actions (specific tasks to be accomplished), and actors (individuals or institutions taking the actions). For example, an ecotourism project might involve setting up a community-based guiding service (the action) to raise income for local villagers who currently work as commercial bushmeat hunters (the threat). This action could be undertaken by almost any type of actor (e.g., a donor or government agency) in service of many different objectives (e.g., conservation, community development). In the classification, we thus restricted ourselves to considering actions.

Multiple Actions versus One Action with Multiple Tasks

In most real-world situations, a project will take multiple actions to deal with different threats and opportunities. However, a project may also take multiple actions to accomplish one objective. Consider the following examples: lobbying a government agency to change regulations to allow for conservation easements and educating private landholders to get them to adopt a

forest-certification system. In our classification, does the first example fit into the (1.3) resource & habitat protection (easements), the (5.2) policies and regulations category, or both? Does the second example fit into the (4.2) training, (6.3) market forces, or both?

The answer depends on the project team's perspective. In the first example, if the team is primarily a lobbying group that is working to benefit other organizations that will implement easements, then they might claim their action is in the policies and regulations category. Similarly, in the second example, if the team is a full-time training provider, then they may claim training as their primary action. For most practitioners, however, the lobbying and education work would merely be precursory tasks as part of broader easement or market-force actions. As a general rule, it is probably better to classify complex actions under one general category rather than assign specific component tasks to different action categories.

Application of the Unified Classifications

The true test of any classification scheme is whether it can be meaningfully applied to real-world situations. The CMP and IUCN parent classifications had been tested with hundreds of projects and thousands of species around the world. To determine how the unified classifications compared with the parent classifications, we applied the new classifications to large data sets to which the parent schemes had been applied previously and then compared the results.

One example involved BirdLife International data classifying threats to 1191 endangered and vulnerable bird species around the world (Fig. 2a). We were relatively easily able to assign post hoc 93% of the 5434 identified threats to one of the new first-level categories (exact match) and a further 3% as a best match (resulting in 3278 total first-level threats), which demonstrates that the new classification met our criteria of being simple, comprehensive, and exclusive. The majority of the threats difficult to assign involved unspecified habitat loss or degradation. The analysis with the new unified threat classification also proved to be a considerable improvement compared with an equivalent analysis that employed the old IUCN threat classification scheme. For example, at the first level, the old IUCN scheme was a mixture of direct threats and stresses. As a result, at the highest level, the overriding threat was habitat loss/degradation (affecting >90% of bird species). With the new scheme, however, the sources of this stress are clearly identified: agriculture and aquaculture (>70%), residential and commercial development (>30%), natural system modifications (>10%), and energy production and mining (>10%). In the old IUCN scheme, only harvesting was shown at the first level (affecting >30% of bird species), whereas in the new scheme, harvesting, logging, and fishing are grouped into the more prominent biological resource use (70%). In the new scheme, invasive and problematic native species are also grouped into invasive and other problematic species (affecting nearly 40% of bird species), drawing attention to this pervasive issue. Finally, in the old IUCN scheme there was just one category for natural disasters, whereas in the new scheme these have been split and now allow for the effects of climate change and severe weather to be differentiated from geological events.

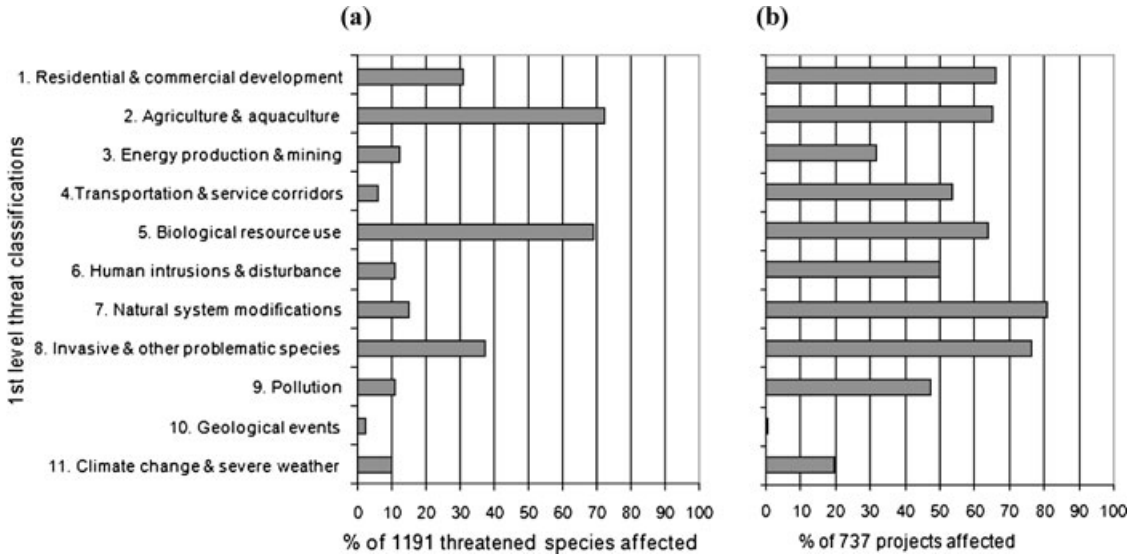

Figure 2. Application of the new threat classification to (a) the percentage of 1191 endangered and vulnerable bird species affected by the first level of threat types (3278 total threats) and (b) the percentage of 737 Nature Conservancy projects affected by the first level of threat types (8683 total threats).

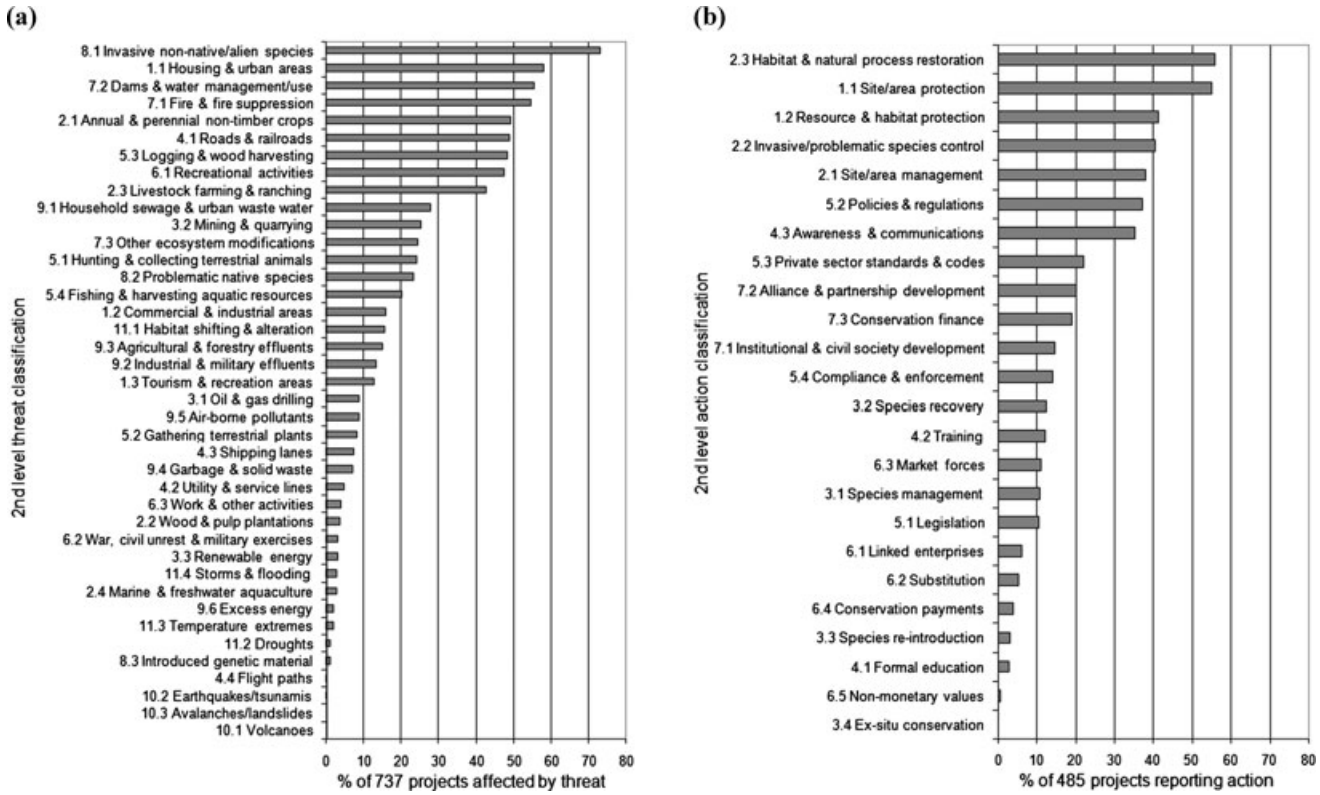

Figure 3. Application of the new threat and actions classifications to Nature Conservancy projects (a) affected by the second level of threat types (8683 total threats across 737 projects) and (b) that either are using or are planning to use conservation actions across the second level of action types (7043 total actions across 485 projects).

Another example involved classifying threats (Figs. 2b & 3a) and conservation actions (Fig. 3b) at Nature Conservancy project sites around the world. Here again, we were able to assign post hoc over 90% of the 8683 identified threats across 737 projects reporting threats to the first- and second-level categories. For the actions classification, the post hoc assignment was a bit more challenging. We were able to assign only 66% of the 7043 total actions across 485 projects reporting any actions to one of the new categories. For both threats and actions, the entries that were difficult to assign were those lacking detailed information (e.g., those listing only a general threat of, e.g., forest loss), so they would have been difficult to assign post hoc to any classification scheme. In almost all cases, it did not seem to be a problem with the classification structure itself. Furthermore, the results of these new classifications were at least as informative as similar analyses conducted with the old CMP classification systems.

In addition to our own tests, the unified classifications have also been tested by many other practitioners, including, for example, being applied to assess grants made by fish and wildlife agencies in a number of U.S. states, to examine tiger conservation efforts around the world, and to classify threats and actions in dozens of specific conservation projects. The testers generally reported that the classifications met our criteria of being simple, hierarchical, comprehensive, consistent, expandable, exclusive, and scalable.

Next Steps

These classifications are now under the editorial authority of the IUCN Classification Schemes Working Group of the IUCN Biodiversity Assessments Sub-Committee of the IUCN Species Survival Commission Steering Committee. For data management purposes, it is important to have classifications that are relatively stable. At the same time we obviously need to allow the classifications to develop over time. To this end the current version 1.1 of each classification will now be locked until the end of 2008 (at least at the first and second levels in each classification). It will still be possible to adjust definitions and expositions and to add additional examples at the

third level. If substantial changes are made, they will be released with a new version number (e.g., 1.2). A formal review process will begin in January 2009, culminating in the release of version 2.0. We then anticipate repeating the cycle every 4 years thereafter.

One important next step will be to continue the development of the classifications to try to make them more comprehensive at the third level and beyond. It is not yet clear whether we will be able to create standard classifications at these lower levels, or whether certain user communities will want to develop their own versions. For example, The Nature Conservancy's freshwater and marine networks have both developed expanded lists of third-level threats within the framework of the unified classification, including specific types of dams (e.g., flood control, power generation) and fishing threats (e.g., trawling, long-line fishing) to meet their specific needs. Another key step will be to go beyond classifying threats to developing a standard way of measuring threat magnitude so as to be able to quantify the relative effects of different threats within a project site and to assess change over time (CMP-IUCN 2007). It will also be useful to develop a better classification of contributing factors, although this will be a challenging task.

Perhaps the most important step will be to broadly disseminate these classifications, with a view to wide adoption by the conservation community. We have been working to distribute the classifications to conservation practitioners and organizations and agencies around the world. We are also including them in several conservation planning tools and databases (e.g., Miradi Adaptive Management software, the TNC ConPro Database, BirdLife's World Bird Database, and IUCN's Species Information System). Just as it has become accepted scientific practice to refer to species by their scientific name alongside their common name, we hope that conservationists too will use the classifications of direct threats and actions to describe and report on their work around the world in a standard fashion. As a result practitioners with access to this information will be able to rapidly download information about projects, species, or sites facing similar threats and information about other practitioners using similar actions.

Conclusions

We presented standard classifications for describing threats and conservation actions. We believe these classifications will be useful for practitioners in 3 ways. First, they will help practitioners identify the direct threats occurring at a particular site or affecting a particular species and what actions might be appropriate to counter these threats. For example, as part of their overall project design and implementation work (CMP 2004), a project team can scan these classifications and see if they recognize any threats that they may be overlooking in their analysis of the conditions at their site, or any actions that they might use.

Second, they will enable managers and decision makers to tally the frequency of threats or actions across projects at various organizational or spatial scales to help set priorities and allocate resources. They will also allow researchers to combine threats and action summaries with other information for more detailed analyses of conservation situations and solutions. For example, it would not have been possible to create Figs. 2 and 3 without these classifications.

Third and most important is that they will facilitate cross-project learning by allowing practitioners to precisely describe the chains linking targets, threats, contributing factors, and actions—their project-specific versions of the general chain in Fig. 1. These chains can then be shared through common databases of conservation practice, thus enabling practitioners to share and compare experiences more readily, ultimately leading to the development of a more systematic science of biodiversity conservation.

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