Opinion Article

A model biodiversity monitoring protocol for REDD projects

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Abstract
Emerging international standards for Reduced Emissions from Deforestation and Degradation (REDD) projects require a demonstrated biodiversity benefit and a biodiversity monitoring protocol. Guidance for an acceptable protocol is proposed specifically for tropical forests, focusing on technologies that are widely available, rigorous, and aimed at important indicator taxa for forest function. Two techniques, camera trapping for large and mesoscale mammals and acoustic monitoring for bats, are proposed as current technologies that meet the criteria for a model biodiversity monitoring protocol for REDD projects.

Keywords: REDD; biodiversity monitoring; bats; climate change; deforestation

Resumen
Recientes estándares internacionales para proyectos de deforestación y degradación con emisiones reducidas (REDD, siglas en inglés), requieren tanto de un beneficio demostrable en biodiversidad como de un protocolo para su monitoreo. Algunas pautas para un protocolo aceptable son expuestas, específicamente para bosques tropicales, basadas en tecnologías ampliamente accesibles, rigurosas, y enfocadas en taxa indicadoras importantes para la función de los bosques. Se proponen la captura de imágenes de mamíferos medianos y grandes a través de cámaras instaladas en el bosque, y el monitoreo acústico de murciélagos, como técnicas actualizadas que cumplen con los criterios de un protocolo modelo de monitoreo de biodiversidad para proyectos de deforestación y degradación con emisiones reducidas (REDD).

Palabras clave: REDD; monitoreo de biodiversidad; murciélagos, cambio climático; deforestación.

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1. Overview of International Standards for REDD and Biodiversity Monitoring

The term Reduced Emissions from Deforestation and Degradation (REDD) encompasses a strategy of forest conservation that can include both conservation and sustainable forestry. Biodiversity conservation is commonly presumed to be a goal and co-benefit of REDD. While the United Nations Framework Committee on Climate Change has not yet confirmed a follow-on agreement to the Kyoto Protocol, preliminary agreements from the most recent conference of parties in December of 2010 in Cancun, Mexico indicate that REDD, including community and biodiversity protections, will be a part of a future agreement. Meanwhile, the voluntary carbon markets have embraced REDD. The Verified Carbon Standard© and the American Carbon Registry® are two independent voluntary standards that have produced protocols for certifying REDD projects. Both include requirements for biodiversity protection. The Climate, Community, and Biodiversity Alliance℠ has produced a standard that includes community and biodiversity benefit certification of REDD projects. A biodiversity monitoring requirement is included [1]. An all-inclusive list of standards and their relative merits is beyond the scope of this communication, but a very comprehensive discussion of voluntary standards has recently been published by Merger et.al. [2].

None of the standards currently proposed include significant guidance on biodiversity monitoring protocols. Many protocols can comply with the standards, depending on situation, environment, and skill set of the project proponents. The most rigorous protocol possible should be encouraged to ensure that REDD projects meet the stated goals of biodiversity conservation.

2. Qualities of a Model Protocol

Many authors have proposed criteria for biodiversity monitoring [3]. The following criteria suggested for REDD projects are most applicable in tropical forest systems, but also have implications for a wide range of habitat types. A model protocol should address indicative taxa, not just IUCN[1] threatened species. Such taxa should also serve as indicators of habitat quality and disturbance. Any method selected should be repeatable, minimally susceptible to observer bias, and achievable with minimal training and equipment. If a technological solution is chosen, that technology should be well tested and well documented in the literature. The methodology chosen should be useful in many environments because REDD projects could conceivably occur wherever in the world that forests occur. The methodology selected should be used in such a way as to ensure statistical validity of the data for detecting changes of a predetermined scale. And finally, the selected methodology should be cost effective compared to other techniques that meet the criteria.

As in protected areas [4], we maintain that it is necessary to assess whether the management of the REDD project areas is achieving the objective of maintaining biodiversity. It will therefore be important to monitor changes and trends in populations of the key indicator taxa. While the IUCN criteria are useful globally, they often may not adequately reflect regional or localized concerns [5-8].

While IUCN categories are applicable to species at the global level, local and regional scales should be used to identify biodiversity conservation targets. Although regional evaluations can lead to global status changes, e.g. [9-10], it is important to consider regional and local criteria when identifying monitoring targets [11]. Rarity of species, an important topic in conservation biology [12-13], is often used at the local and regional scale when identifying species of conservation concern and should also be included in consideration of monitoring targets.

[1] International Union for the Conservation of Nature

3. Camera Trapping

Camera-trapping is an effective method for detecting medium-to-large animals, and occasionally even small species. Such species may have IUCN designations, be locally sensitive, or be effective as indicator species. Initially developed as a tool for hunters, camera-traps have been utilized for at least 100 years [14]. Technological advances have made camera-trapping even more effective and user-friendly during the last 20 years and today, digital cameras are the standard. This survey method employs remotely stationed motion-sensitive cameras that take photographs of passing animals. Nocturnal infra-red flash photography, which animals cannot see, makes photo-captures possible 24 hours a day.

Camera-traps are typically used to gather baseline data, to document trends (increase, decrease or no change), and to conduct long term monitoring and other ecological investigations [15]. They have been used in a wide variety of habitats for diverse species, (see [16-19]). Camera-trapping is an effective method for mark-recapture studies, since uniquely marked animals such as spotted cats can be recognized, particularly when cameras are paired so that both sides of the animal are photographed. Several tools exist for data analysis, such as Camera Base 1.3. [20]. A system for retrieval, storage, analysis, and sharing of camera-trap data has been developed and put into practice [14]. Another example is the Wildlife Picture Index (WPI), an indicator effort recently proposed to monitor trends in tropical biodiversity [21].

Camera-traps are cost effective because they essentially “replace 100 biologists on the ground, 24 hours per day” for weeks or months at a time [15]. After the initial investment, they are cost effective over time. They operate both day and night, in nearly any landscape or vegetation cover, for the life of their batteries, which can be months. They are non-invasive with minimal bias. Resulting photos are automatically date/time stamped and provide unambiguous archivable data, unlike more ephemeral data such as tracks or scat. In addition, interesting animal behavior of scientific interest may be recorded. Resulting images often have value for education or promotional purposes.

A disadvantage is possible theft. Many units come in discreet colors or “camouflage” with a cable-lock system to minimize that possibility.

4. Acoustic Monitoring

Nearly one-quarter of the world's mammal species are known to be globally threatened or extinct [22]. Approximately 22% of all bat species are considered threatened, and a further 23% are Near Threatened [23]. In the Neotropics bats also comprise > 50% of the terrestrial mammal species. In addition to those bat species of conservation concern, all bats provide critical ecosystem services which directly impact plant populations [24], particularly in regard to tropical forests maintenance and re-generation. Globally, forests are the centers of the highest bat diversity [22, 25]. Bats also serve as indicators of habitat quality [26-30] and reflect even minor habitat perturbations [31].

There are three types of bat detectors and associated recording devices used to detect bat echolocation calls: heterodyne, full spectrum and zero crossing [32]. The latter two are widely used for automated monitoring for species identification and estimation of relative abundance. Such systems are now used for both pre- and post-construction monitoring of wind power projects (e.g., [33-35]).

The identification of free flying bats by their unique species-specific vocal signatures makes it possible to automate non-invasive monitoring of bats using acoustic sampling. While not every species has yet been recorded with verified vocal signatures, many forest dwelling species are now well documented [36-41]. The Acoustic Activity Index also makes it possible to calculate and automate relative abundance estimations for the species monitored [42].

The choice of acoustic monitoring equipment depends on the project personnel and capabilities. Systems can range from fully automated, solar powered, with remote data access and equipment management, to simpler systems that require field technicians to visit monitoring stations to retrieve data and recharge monitoring station batteries at fixed time intervals. The cost of such system hardware will vary with the level of automation chosen, as well as the time investment of field personnel. As the level of automation of recording stations increases, the levels of field technician time and personnel costs decrease.

The trade-off of upfront equipment costs vs. long term field personnel replete with benefit packages etc. needs to be evaluated on a project-by project-basis; ease of access to monitoring sites must also be considered. Frequently the logistics of getting to and from monitoring sites on a regular basis for maintenance and data retrieval is not cost effective and may be quickly off-set by automated equipment costs. The bat call identification and data analysis requires personnel with adequate experience and skill sets and may be readily centralized in a single office to manage multiple projects and/or monitoring locations, thereby making it even more cost effective and avoiding redundancies. Additionally, all acoustic records serve as vouchers, just as museum specimens or photographs do. Unlike visual records, they are archived and available for future reference.

An additional benefit of automated acoustic monitoring results from the expanding field of bioacoustics. Increasingly, rapid acoustic analysis of the sounds produced within broader animal communities is being used to estimate and compare diversity [43]. For example, trends in bird population sizes are important indicators for monitoring conservation and habitat change, but measuring populations has been a very difficult, labor intensive process.

Enormous progress in audio signal processing and pattern recognition in recent years makes it possible to incorporate automated methods into the detection of bird vocalizations [44]. Research into the automated identification of animals by bioacoustics is becoming more widespread, mainly due to difficulties in carrying out manual surveys [45]. Technology is now available to utilize two-channel acoustic recording equipment to monitor bats (ultra sound) on one channel at night and use the other channel for vocal species such as nocturnal and diurnal birds, frogs and, in the tropics, monkeys.

4. Conclusions

Paying close attention to these criteria will help ensure that the monitoring program can actually detect changes in the indicative taxa for the system. International standards for co-benefits are very dependent on project-level monitoring and 3rd-party independent auditing, and without defensible data, the standards are rendered immaterial. Basic training for field technicians to set up and maintain the monitoring stations and retrieve data can be accomplished with short training sessions. The additional benefit of having a “centralized” data processing location utilizing personnel with higher levels of training will also be cost effective for large landscape level projects and for many smaller projects. Using standardized equipment (e.g., camera traps and acoustic monitoring stations), data analysis and management protocols will more likely lead to robust, repeatable, defensible data comparable over time, between sites . Ultimately, automated methods for sampling forest species will be the most cost effective means for monitoring habitats, habitat change, and key bio-indicators regardless of their global IUCN conservation status.

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