Social development and freshwater fisheries conservation: lessons learned from monitoring conservation agreements in the Colombian Amazon

Margarita Mora[1], Eduard Niesten[2], Erwin Palacios[3], Francis Palacios[4] and Isaí Victorino[5]

Abstract: Many environmental issues can be attributed to misaligned distribution of the costs of conservation and the benefits of conservation. For instance, biodiversity represents value for the global community, but biodiversity protection imposes various costs on local communities in forested areas of developing countries. Correcting this misalignment requires presenting these local communities with appropriate incentives. Conservation agreements – negotiated transactions in which conservation investors finance direct social benefits in return for conservation actions by communities – are one tool for doing so. The results of this approach depend crucially on effective monitoring of both ecological and socio-economic impacts to verify that environmental and development objectives are met in a socially equitable, economically efficient, and financially sustainable way. Monitoring also is needed to verify that parties to the agreements are in compliance with their commitments. This paper will present the conservation agreement model and demonstrate the central role of robust monitoring frameworks, using the example of agreements between Conservation International and communities in the Colombian Amazon. These agreements are designed to protect forest areas and two endangered species of fish that are important to local livelihoods and have a high commercial value in neighboring countries. A key feature of this project is that the agreements both depend on and strengthen social and resource governance within the partner communities, thereby promoting self-determination while enhancing the overall context for socio-economic development. At the same time, lessons generated by this project inform emerging frameworks for scaling up the approach to advance conservation and development at the national level, requiring integration with national policies. The paper will conclude by identifying the strengths and limitations of the conservation agreement approach, emphasizing that effective monitoring is essential for success and exploring the implications of scaling-up for design of monitoring frameworks.

Introduction

Biodiversity represents value for the global community, but conservation of habitats, species, and natural resources involves non-trivial costs for local communities in developing countries (Balmford *et al.* 2002). These costs pose a barrier to the behavior change needed to achieve conservation outcomes, giving rise to the need for appropriate incentives to help local communities overcome the cost of conservation. Conservation International (CI), through its Conservation Stewards Program (CSP), has used a model it calls conservation agreements (CAs) to create such incentives in a portfolio that

[1] Consultant/Regional Manager for Latin America - Conservation International/Conservation Stewards Program. E-mail: mora.csp@gmail.com
[2] Senior Director - Conservation International/Conservation Stewards Program.
[3] Amazon Program Coordinator – Conservation International Colombia
[4] Researcher/Consultant – Fundación Omacha Colombia
[5] Researcher/Consultant – Conservation International Colombia

currently includes 64 projects around the world (Niesten *et al*. 2010). In essence, CAs are a form of direct incentives for conservation, in which conservation investors provided a negotiated benefit package in return for conservation actions by communities (Engel *et al.* 2008; Ferraro 2001; Ferraro and Kiss 2002; Simpson and Sedjo 2006). Thus, CAs link conservation funders (governments, bilateral agencies, private sector companies, foundations, individuals, etc.) to resource owners whose decisions influence conservation outcomes (Wunder 2007).

In this paper we present the conservation agreement model and show how CAs are being used in Colombia's Amazon region to conserve freshwater fish species. As a key determinant of success for CAs involves periodic monitoring of biodiversity and socio-economic trends, the paper will discuss results obtained from the most recent monitoring efforts in the project. We conclude by identifying strengths and limitations of the conservation agreement approach, emphasizing that effective monitoring is essential for success and exploring the implications of scaling-up for design of monitoring frameworks.

The Conservation Agreements model

CSP's CA model consists of four main phases: site definition and feasibility analysis, engagement with resource users (communities or individual owners) to familiarize them with the CA model, agreement design and negotiation with the resource users, and implementation. The feasibility analysis informs implementers whether a CA may be the right conservation tool for a given site. If the feasibility analysis yields a positive conclusion, the implementer approaches the resource users to explain the CA model and gauge interest in collaborating to develop an agreement. Once resource users explicitly express interest in pursuing an agreement, they and the implementer initiate the process of CA design.

A CA specifies the rights and responsibilities of the parties involved, conservation commitments of resource users, benefits to be provided by the implementer, and sanctions for non-compliance. Most agreements involve two parties, one that undertakes conservation actions and one who provides benefits and technical support for those actions. Depending on the resource property rights context, other parties such as government may be involved. Resource users' commitments in the CA are based on the conservation objective; they can include direct change of behavior (e.g. stopping slash and burn practices) as well as actions to reduce external pressure (e.g. poaching by outsiders). Benefit packages are defined based on the opportunity cost of conservation - the value of foregone resource use (e.g. income reduced by not expanding crop fields) and the cost of conservation actions (e.g. time spent

patrolling). Benefits can include cash payments (e.g. patrolling wages) as well as investments in activities and infrastructure that benefit resource users as a group (e.g. improvement of small-scale irrigation infrastructure).

A key feature of CAs is that benefits are contingent on compliance with conservation commitments. Graduated penalties are defined jointly by implementers and resource users as part of agreement design. These sanctions usually start with an admonishment letter in which resource users are asked to undertake corrective actions. If noncompliance persists, the benefit package is reduced temporarily, allowing a restoration of full benefits once the needed actions are taken. Finally, if the agreements are continuously breached, implementers stop providing the benefits and terminate the agreement (Gjertsen and Niesten 2010).

Often, an agreement initially is signed for a one-year period; if the CA works well it is renegotiated for another year. After a period of three to five years, if the agreement continues to be effective, sustainability mechanisms are defined to support a transition to a long-term agreement. Financial sustainability can be pursued by establishing trust funds, linking the CA to other Payment for Environmental Services (PES) schemes (e.g. carbon sequestration, watershed protection), or promoting government programs that support conservation and poverty alleviation through agreements. With respect to management, sustainability involves improved governance capacity on the part of resource users and strengthening local leaders, to reduce reliance on technical support from the implementer. Once sustainability mechanisms are in place, the agreement can be signed for a longer duration.

Monitoring Conservation Agreements

Monitoring is central to the functioning of a CA, as the results depend crucially on effective monitoring of both ecological and socio-economic impacts to verify that environmental and development objectives are met in a socially equitable, economically efficient, and financially sustainable way. Monitoring also is needed to verify compliance with the agreements, and the presence of meaningful monitoring itself can be a significant driver of behavior change (Sommerville *et al*. 2010).

Monitoring of compliance often is done by the implementers. Typically implementers spend much time in the field providing technical assistance, project follow-up, and the like, and thus can directly observe agreement compliance. In addition, implementers should devise systems that encourage resource users to report infractions by others, and also must ensure that sanctions are applied. Annual reviews of the

agreement by the implementers and resource users permits examination of what has been accomplished and analysis of why some conservation commitments may not have not been fulfilled.

To ensure impartial results, biodiversity monitoring is usually carried out by third parties (i.e. someone other than the implementer or resource users). Each CA has measurable conservation goals (e.g. number of hectares conserved or population of a particular species maintained/increased). A biodiversity baseline is determined once the agreement is first signed, and then biodiversity monitoring is carried out each year to track progress on the conservation goals. Monitoring results are used to assess impact of conservation actions and refine agreements over time to increase efficacy. Also, involving resource users in biodiversity monitoring efforts has been a successful empowerment and engagement strategy in several of CSP's CA sites (e.g. Cambodia, China, and Guatemala).

Whenever possible, socio-economic monitoring is also conducted by third parties. As with biodiversity monitoring, a socio-economic baseline is established in the first year of the agreement and afterwards monitoring is performed annually. The purpose of periodic socio-economic monitoring is to understand how socio-economic conditions of resource users change during CA implementation, and to track the impacts of the agreement on the wellbeing of resource users. Socio-economic monitoring also examines perceptions of resource users about the agreement and the benefits provided, as these perceptions will influence the degree of compliance. Thus, socio-economic monitoring informs adaptation of CAs during renegotiations to ensure that benefits conform to resource user priorities and that resource users are satisfied with the CA design and implementation.

Conservation agreements and freshwater fisheries

In 1998 CI-Colombia began working in La Pedrera, a *corregimiento*[6] in the Amazonas Department of Colombia near the border with Brazil. Initially the main objective was to develop management plans for three Indigenous Reserves and two *Veredas*[7], each composed of several communities. The resulting plans included areas set aside for conservation, but, though interested in conserving their lakes, creeks and forest, the communities lacked the means to carry out patrolling activities. Outsiders continued to fish Pirarucu (*Arapaima gigas*) and Arawana (*Osteoglossum bicirrhosum*) in lakes and creeks within the conservation areas, using destructive methods and harvesting fish smaller than the legal minimum

[6] *Corregimiento* is a subdivision within Colombian Departments, usually with less population than a municipality.
[7] *Vereda* is similar to a rural district. In this particular case the two veredas are part of the *corregimiento* of La Pedrera.

catch-size. Pirarucu are sold in restaurants, while Arawana are taken to Bogotá where they are exported as ornamental fish to the European Union, United States and Japan. Destructive methods used by fishermen also impact other species such as black caimans (*Melanosuchus niger*), giant otters (*Pteronura brasiliensis*), giant river turtles (*Podocnemis expansa*), and other fish species that are important protein sources for local communities. Thus, the conservation areas remained under pressure.

In 2007, CI-Colombia and CSP established CAs with eight communities in the three Indigenous Reserves and two *Veredas* to ensure the conservation of Pirarucu, Arawana and other species. These agreements were motivated by repeated reports from locals that the populations of Pirarucu and Arawana were in steady decline. The communities involved in the initiative were selected based on their proximity to the lakes and creeks to be conserved and their interest in developing conservation strategies that can help them accomplish the objectives stated in their territorial management plans. The CAs also included the protection of forest areas surrounding the lakes, thereby promoting the conservation of 400.000 hectares of fresh water ecosystems and their surrounding forest.

Under the agreements the communities committed to stop fishing Pirarucu and Arawana in the protected lakes and creeks, forbid fishing during the spawning season, use artisanal fishing gear, establish fishing quotas for other species, and participate in surveillance activities to prevent outsiders from fishing in their conservation areas. Patrolling teams consist of three people from different families. Each patrolling campaign lasts 30 days. If outsiders (or insiders) are found fishing for Pirarucu or Arawana in protected lakes or creeks, patrollers inform the natural resource committee of their Indigenous Reserve or *Vereda* who then report the incident to the authorities. Additionally, patrollers participate in the Pirarucu and Arawana monitoring exercises, as the monitoring methodology incorporates their knowledge about the species. In exchange for these efforts, community members receive an economic incentive in cash equal to the prevailing wage rate. Patrol team members rotate every month to make sure most families in each community can participate in and benefit from patrolling activities. The benefit package also includes funds for the natural resource committees to ensure they have the means to report problems to authorities and also to promote the CA model in neighboring communities. Indirect benefits of the agreements include strengthening of community leadership and governance, enhancing territorial rights of the communities by giving them the means to patrol their land, and recovery of Pirarucu and Arawana populations in the conservation sites that are also sacred sites to some of the communities.

The agreements explicitly define graduated sanctions to be applied in case of noncompliance. Each community defined internal sanctions for members who breach the agreements, based on the severity of the infraction. Internal sanctions are important improve social control within the communities. Minor infractions (e.g. using project equipment for non-project travel) first result in a warning, and after a second offense are penalized by a 10% reduction in wages. If noncompliance persists, the offender is expelled from the project for six months. Serious infractions (e.g. not performing patrolling duties) result in a 20% reduction in wages paid. A second offense leads to a six-month suspension from the project. Sanctions for very serious infractions (e.g. taking Pirarucu and Arawana from protected lakes) include expelling the transgressor from the project for one year. CI-Colombia applies external sanctions only when communities do not apply internal penalties. A community that does not comply with its commitments loses 10% of its benefit package for two months; these funds can be recovered if the breach is satisfactorily resolved. Upon a second breach, a community forfeits 20% of the annual payment, and the CA is terminated in the event of a third breach. The communities also can apply sanctions to the implementer in the event of failure to deliver technical support or benefits on time: on the first occasion CI-Colombia must pay $90 to the community fund, the second time $180, and the third time $270. The sanctions are decided on and applied during monthly meetings held between the communities and CI-Colombia.

Biological monitoring has been carried out every year since the agreements were established. The National University of Colombia and CI-Colombia developed the monitoring protocol based on the knowledge of the communities. The biodiversity baseline was established in 2008. Afterwards the University of Antioquia continued with the monitoring activities using Castello's (2001, 2004) monitoring methodology, which consists of counting individuals breathing on the lake surface. They divided the lakes into two systems, the Várzea system and the Igapó system. Within these systems lakes are divided into two-hectare sections and monitoring is carried out by community members for two hours in each section. As the adult Pirarucu go to the surface to breath every 15 to 20 minutes, the participants have to count the number of sightings and judge whether they have previously counted the same individual. The Arawanas swim in schools near the surface of the lakes, which can be seen easily from a high position (e.g. a boat with high chairs or a tree on the lake edge). As for the Pirarucu, the methodology consists of dividing the lake into two-hectare zones. Each member of the community is located on a specific spot and they have to count the number of Arawana schools and the number of young and adult individuals within the schools in a two hours period (Duque *et al.* 2008).

Socio-economic monitoring is conducted by consultants from the National University of Colombia and the CI-Colombia team. The consultants adapted Trujillo's (2008) methodology for socio-economic characterization of indigenous households. They defined indicators to measure population distribution by gender and age, ethnicity, language, education, household economic characterization, land access, access to drinking water and other basic services, and knowledge about the agreement. To gather the data they carried out surveys and interviews in all 61 households of the eight communities involved. To understand the socio-economic and territorial context of each community, they developed a characterization form that includes data about the communities' size, localization, infrastructure, productive activities, and migration rate (emigration and immigration) (Lasprilla-Lopez and Trujillo-Osorio 2008).

4. Results to date

The results of the conservation agreements can be assessed using the biodiversity and socio-economic reports. In this section the most important results presented in the 2010 reports will be presented. The 2010 reports include information from the previous monitoring campaigns.

Biodiversity monitoring

The 2010 biodiversity monitoring results showed that in the Várzea lakes system the population density of Pirarucu declined in 2009, but increased in 2010. However, the number of Pirarucu per hectare reported in 2010 was not as high as in 2008. The population density differs among years due to the hydrological and meteorological conditions when doing the monitoring. Pirarucu monitoring is most effective if done when the lakes have no connection to rivers or creeks, but in 2009 delays led to monitoring being done when lake waters ran into rivers and creeks. Thus, the Pirarucu moved into flooded forest areas, preventing an accurate count. The 2008 monitoring exercise oversampled Pirarucu individuals in one lake of the system, resulting in a population overestimate. This occurred because juvenile individuals breed more frequently than initially assumed in the methodology, which led to overcounting. During 2010 juvenile and sub-adult individuals were sampled that probably were in the flooded forest during the 2009 monitoring. In general the results show that the Pirarucu population in this lakes system is recovering (Moreno-Arias and Moreno-Arias 2010).

In the Igapó lakes system monitoring was carried out in 2009 and 2010, as the communities involved entered the program in late 2008. The results show a reduction of 28.5% of the Pirarucu population

density in this period. The population decline is attributable to the reduction of the water level of the lakes compared to the previous year. Thus some of the individuals could have been hiding in the riverbed during the monitoring, where it is difficult to spot them. Illegal extraction of Pirarucu from this lake system has declined, but one outsider continues to fish in one of the lakes, as the community is afraid to confront him (Moreno-Arias and Moreno-Arias 2010). For this reason the agreement with this community was not renewed in 2010; this CA could be reestablished in 2011 if the community solves the problem.

With regards to the Arawana, the monitoring results suggest a decline in population between 2008 and 2010 (14.34 ind/ha in 2008, 3.99 ind/ha in 2009, and 3.23 ind/ha in 2010). However, the methodology used to measure Arawana density is easily affected by weather conditions, as when ripples due to raindrops or wind reduce visibility of Arawana. The methodology used for monitoring Arawana was developed based on the Pirarucu methodology, but has proven unsuitable because, unlike the Pirarucu, Arawana swim in rapidly moving schools. Therefore a single group can easily be counted multiple times by the observers, and observers easily count different numbers of individuals per school depending on their monitoring skills (Moreno-Arias and Moreno-Arias 2010).

Socio-economic monitoring

Socio-economic monitoring suggests that every community experience a reduction of income over the past year, as there were less daily jobs available and people sold less timber. Income provided by the CAs ranged from 6% to 20%. The importance of CA benefits in the local economy varies according to the proximity of the communities to markets and the ethnic and demographic composition of the communities. For example, Villa Marcela and Madroño are mainly composed by mestizos and are located near the main towns, and have the highest per capita incomes. As they have fewer households than the other communities, the families participate in the patrolling activities more than once per year. Consequently in these communities the CA incentives represent between 15% and 20% of total income. Communities farther from the main towns are mainly indigenous, have lower per capita incomes, and have less diversified income sources. Fishing remains one of the main income sources, as in Ñumi, located in the Igapó lakes system, where fishing contributes 50% of income. As there are more families in the Indigenous Reserves than in the Veredas, the CA incentives account for less than 10% of total income (Lasprilla-López and Trujillo-Osorio 2010).

With regard to the CAs themselves, the monitoring results show that 97% of community members know that CAs are in place and consider them an effective tool to protect freshwater ecosystems and to control overfishing of Pirarucu and Arawana. They have a positive perception of Pirarucu and Arawana recovery. In 2010 the communities emphasized the importance of non-cash benefits provided by the agreements, such as the protection of their territory and resources, rather than the wage-earning opportunities. Monitoring revealed some problems related to the rotation patrolling system, as some members feel that a few people carry out patrolling activities more often than others. Additionally, despite recognizing the need for penalties in the event of non-compliance, the sanctions system is unknown to most people (Lasprilla-López and Trujillo-Osorio 2010).

5. Discussion

The agreements in Colombia depend on and strengthen social and resource governance within the partner communities, thereby promoting self-determination while enhancing the overall context for socio-economic development. At the same time, lessons generated by this project inform emerging frameworks for scaling up the approach to advance conservation and development at the national level, requiring integration with national policies. This section discusses the conservation and socio-economic results from this experience.

To monitor success of the CAs, periodic assessments must be done with the resource users. In Colombia, the team participates in community assemblies held every six months to review compliance with the agreements. The CI-team also goes frequently to community meetings held at the maloca[8], where people feel more free to speak about results of the CAs than in formal household interviews. Additionally the participation of the communities in biodiversity monitoring has been crucial for the CAs, as they know the results reflect how well they are patrolling the lakes and creeks. Thus, their participation in monitoring campaigns has helped strengthen social control as they are aware that if the results are not satisfactory the CAs could end.

The Pirarucu and Arawana population densities currently seen in the lake systems studied are a result of overfishing prior to the establishment of CAs. Individuals of both species need about five years to reach sexual maturity, but 95% of the mortality of Pirarucu and Arawana occurs during the early development phases, causing problems for natural stock increase. The experience in the Colombian Amazon shows

[8] *Maloca:* ancestral long house used by indigenous groups of the Amazon, particularly in Colombia and Brazil.

the difficulty of gathering good quality data to monitor biodiversity changes, as the data collected can be easily affected by weather and hydrological conditions. Additionally, the monitoring protocol for Arawana has not been as reliable as expected, and a new methodology needs to be developed. This shows the risks of using a species as an indicator when there is no tested monitoring methodology. Moreover, there is a need to monitor sites where CAs are not being implemented, as control sites that allow comparison to the data obtained from CA areas. Therefore, despite anecdotal evidence from local communities, it is too early to say on a scientific basis the degree to which CAs have increased Pirarucu and Arawana populations in the two lake systems.

Regarding socio-economic aspects, periodic monitoring provides insight into the influence of the CAs on the local economy. Monitoring results indicate that economic security of the communities is very fragile, and the CA incentives provide the only reliable income source to buy goods and services that were unaffordable before the agreements were established. Monitoring results also show that indirect benefits are very important to these communities, so that in addition to a direct income source a CA provides the means for institutional strengthening at the local level.

With respect to implementation, equitable distribution of benefits is a significant challenge. Also, when providing direct payments, implementers must follow up on how funds are used or the economic incentive can be used in ways detrimental to families' wellbeing. Another important issue relates to conditionality of the benefits in the agreements; community members who are unaware that sanctions will be applied in the event of noncompliance might be less inclined to observe the agreement. Thus, community members must be informed about the sanctions and apply them when appropriate. At the same time, implementers and funding organizations must realize that behavior change takes time; resource users need to adjust to the CA model and this can take more than a couple of years. Nevertheless, the results obtained to date suggest that the CAs in the Colombian Amazon are important for household economies and that behavior is changing significantly throughout these communities.

Finally, CAs are one tool for achieving conservation, and in many cases they must be accompanied by other actions. In the Colombian Amazon, CAs will not succeed without support from local authorities. Community rangers can inform outsiders that fishing Pirarucu and Arawana is forbidden, but they cannot apprehend transgressors or confiscate fishing gear as they do not have the legal authority and to do so would put their lives at risk. Therefore these communities need political and legal support from Colombian and Brazilian authorities, including support from the environmental police of Colombia and

the army of Brazil. One option being explored is the adoption of the CA model by the Colombian Institute for Rural Development (INCODER), a government organization in charge of managing freshwater fisheries. This would encourage other communities to use a similar approach to conserve their freshwater resources, and give the CAs enhanced legal standing. However, expansion of this nature would also imply potential challenges related to monitoring compliance, conservation outcomes and wellbeing impacts on a larger scale. Replicating the model would magnify the costs of annual monitoring campaigns to determine fine-scale conservation and socio-economic impacts at many sites. Thus, monitoring frameworks must be adapted to the scale of implementation. Experience with CAs in Colombia and other countries around the world have shown that effective biodiversity and socio-economic monitoring frameworks are needed to determine empirically whether CAs are accomplishing the stated biodiversity and socio-economic goals.

References

Balmford, A., A. Bruner, C.P. Cooper, R. Costanza, S. Farber, R.E. Green, M. Jenkins, P. Jefferiss, V. Jessamy, J. Madden, K. Munro, N. Myers, S. Naeem, J. Paavola, M. Rayment, S. Rosendo, J. Roughgarden, K. Trumper, and R.K. Turner, 2002. Economic Reasons for Conserving Wild Nature. *Science* 297: 950 – 953.

Castello, L. 2001. *Stock assessment and management of Arapaima gigas in the North Rupununi, Guayana.* Instituto de Desenvolviminto Sustentável Mamirauá. Brasil.

Castello, L. 2004. A method to count Pirarucu *Arapaima gigas*: fishers, assessment, and management. *North American journals of fisheries management*. 24: 379-389.

Duque S.R., S. López-Casas, I.B. García-Vega, and L.M. Bravo-Osorio. 2008. *Ecología participative para el manejo integral de humedales y recursos pesqueros en lagos de la cuenca del Río Caquetá (Amazonía Colombiana).* Universidad Nacional de Colombia sede Amazonía and Conservación Internacional Colombia. Unpublished document. Colombia.

Engel, S., S. Pagiola, and S. Wunder, 2008. Designing Payments for Environmental Services in Theory and Practice: an Overview of the Issues. *Ecological Economics* 65: 663-674.

Ferraro, P.J., 2001. Global Habitat Protection: Limitations of Development Interventions and a Role for Conservation Performance Payments. *Conservation Biology* 15: 990-1000.

Ferraro, P. J. and A. Kiss, 2002. Direct Payments to Conserve Biodiversity. *Science* 298: 1718-1719.

Gjertsen, H. and E. Niesten, 2010. Incentive-based Approaches in Marine Conservation: Applications for Sea Turtles. *Conservation and Society* 8: 5-14.

Landell-Mills, N. and I.T. Porras, 2002. Silver Bullet or Fool's Gold? A Global Review of Markets for Forest Environmental Services and their Impact on the Poor. International Institute for Environment and Development, London.

Lasprilla-López, V.A. and C. Trujillo-Osorio. 2008. *Aspectos socioeconómicos para la evaluación del funcionamiento de acuerdos comunitarios de conservación, en las comunidades del Bajo Río Caquetá.* Unpublished document. Colombia.

Lasprilla-López, V.A. and C. Trujillo-Osorio. 2010. *Aspectos socioeconómicos para la evaluación del funcionamiento de acuerdos comunitarios de conservación, en las comunidades del Bajo Río Caquetá.* Segundo Año de Programa. Unpublished document. Colombia.

Moreno-Arias, C. and L. Moreno-Arias. 2010. *Ecología participativa para el manejo integral de humedales y recursos pesqueros en los lagos de la cuenca baja del Río Caquetá y Apaporis (Amazonía Colombiana). Fase III: Informe final.* Universidad de Antoquia y Conservación Internacional Colombia. Unpublished document. Colombia.

Niesten, E., P. Zurita and S. Banks. 2010. Conservation agreements as a tool to generate direct incentives for biodiversity conservation. *Biodiversity* 11: 5-8.

Simpson, R. D. and R.A. Sedjo, 1996. Paying for the Conservation of Endangered Ecosystems: a comparison of direct and indirect approaches. *Environment and Development Economics* 1:241-257.

Sommerville, M., E.J. Milner-Gulland, M. Rahajaharison, and J.P. Jones, (in press). Impact of a Community-Based Payment for Environmental Services Intervention on Forest Use in Menabe, Madagascar. *Conservation Biology* 21: 48-58.

Trujillo, C. 2008. *Selva y mercado: exploración cuantitativa de los ingresos en hogares indígenas.* Tesis para optar al título de Magíster en Estudios Amazónicos. Universidad Nacional de Colombia. Amazonas Colombia. Unpublished document. Colombia.

Wunder, S., 2007. The Efficiency of Payments for Environmental Services in Tropical Conservation. *Conservation Biology* 21: 48–58.