Research Article

Measuring success in a community conservation project: local population increase in a critically endangered primate, the yellow-tailed woolly monkey (*Lagothrix flavicauda*) at la Esperanza, northeastern Peru

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Abstract
The yellow tailed woolly monkey (*Lagothrix flavicauda*) is one of the world's most threatened primate species. It is endemic to a small area of montane forest in northern Peru, an area with high immigration and deforestation rates. Since 2007, community conservation actions have been implemented in the area of Yambrasbamba, a farming community in Amazonas department. These actions included the signing of voluntary pledges by local villagers to control hunting and forest clearance. A first population density survey was carried out in 2008/9, shortly after the implementation of these pledges; a second survey in the same area that replicated the methods used in the previous survey was carried out in 2012/13. Using transect width estimation from line transects and a Normalized Difference Vegetative Index (NDVI) from satellite images, we compared population density and deforestation rates between surveys. Results showed an increase in the *L. flavicauda* population at the study site, with significant increases in densities of infant (P <0.001) and juvenile individuals (P = 0.019). This suggests that increases are from natural population growth rather than the in-migration of groups or individuals from outlying areas. The NDVI showed low levels of deforestation still occurring in the area, but at a lower rate than the regional and national averages. Our results provide compelling evidence that Community Conservation projects can be successful in highly populated areas, and we urge conservation practitioners to involve local actors when planning and implementing initiatives.

Keywords: Transect width estimation; Hunting; Census; Normalized Difference Vegetative Index; *Oreonax*

Resumen
El mono choro de cola amarilla (*Lagothrix flavicauda*) es una de las especies de primate mas amenazadas del mundo. Esta especie, es endémica de una pequeña área de bosque montano en el norte de Perú, un área con altas tazas de inmigración y deforestación. Desde 2007, fueron implementadas acciones de conservación comunitaria en el área de Yambrasbamba, una comunidad campesina en el departamento de Amazonas. Estas acciones incluyeron la firma de compromisos voluntarios por parte de pobladores locales para el control de la caza y la deforestación. Un primer estudio de la densidad poblacional fue realizado en 2008/9, poco después de la puesta en práctica de estos compromisos; un segundo estudio en la misma área replicando los mismos métodos utilizados en el estudio anterior fue llevado a cabo en 2012/13. Usando Estimación del ancho del transecto y un Índice de vegetación diferencial normalizado (NDVI) a partir de imágenes satelitales, se comparó la densidad poblacional y las tasas de deforestación entre ambos estudios. Los resultados mostraron en el sitio de estudio que la población de *L. flavicauda* tuvo aumentos significativos en la densidad de los individuos infantiles (P <0.001) y juveniles (P = 0.019). Esto sugiere que los aumentos son de crecimiento natural de la población y no de inmigración de grupos o individuos de las zonas periféricas. El NDVI mostró bajos niveles de deforestación que, aunque siguen ocurriendo en la zona, suceden a un ritmo menor que los promedios regionales y nacionales. Nuestros resultados proporcionan evidencia convincente de que las metodologías de conservación comunitaria pueden tener éxito en áreas altamente pobladas e insta a profesionales de la conservación a planificar e implementar estas iniciativas en los actores locales.

Palabras clave: Estimación del ancho del transecto, Cacería, Censo, Índice de vegetación diferencial normalizado, *Oreonax*

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Introduction

The yellow-tailed woolly monkey (*Lagothrix flavicauda*) is one of the largest and rarest Neotropical primates. It is endemic to a small area of cloud forest in the Peruvian regions of Amazonas, San Martín, Huánuco, Loreto and La Libertad [1]. It is still unclear how many remain in the wild, with best estimates in the thousands of individuals [2, 3]. What is certain is that pressure is increasing from deforestation, commercial and subsistence hunting, the pet trade, local development, and resource exploitation [1, 2, 4]. This species is Critically Endangered [5], and three times since 2000 [6-8] it has been listed as one of the world's 25 most threatened primate species.

The Yellow-Tailed Woolly Monkey Project run by Neotropical Primate Conservation was initiated in 2007 [9]. Since its inception, the project has used the Critically Endangered *Lagothrix flavicauda* as a "flagship species" for an informal network of conservation projects throughout the eastern Andean highlands of northern Peru. The project is based in La Esperanza and has used various means to promote conservation locally, including: land protection; research; reforestation; education; economic alternatives; and voluntary conservation agreements. Shortly after voluntary community pledges to protect *L. flavicauda* in the beginning of 2008, a first population census was conducted on *L. flavicauda* during 2008-2009 [10] to calculate the species' initial population densities at the site, prior to conservation work taking place. The current study provided comparative results using three different techniques and showed that densities of *L. flavicauda* at La Esperanza were similar to those reported from other areas [11, 12]. However, methodological issues meant that direct comparisons among the studies were impossible [10].

Horwich and Lyon [13] define Community Conservation (CC) projects as low budget projects that motivate and stimulate local people to assume ownership and responsibility over their natural resources. These projects concentrate on the smallest geographical scale, but have the potential to expand to regional level through reproducing initiatives in neighboring communities. They promote conservation through social values rather than through economic incentives, thus leading to stewardship of nature. Incentives such as economic alternatives are often integrated with the projects at later stages. Although these projects are very common in rural areas and predominantly successful, big conservation agencies seldom acknowledge or support them because of their relatively small scale and geographic isolation [13]. Seymour [14] suggested that the success of Community Conservation projects depends on the intrinsic capacity and traditions of the specific community to organize their resource use, rather than on the external project, and successful projects are therefore 'discovered' rather than designed as such. Locally run conservation projects are increasingly common around the world [15-17] but get little attention in academic literature [17-20]. Shanee et al. [21] described local conservation initiatives in northeastern Peru, dividing them into formal conservation initiatives, including locally run protected areas registered with the government under any of the schemes permitted by law, and informal conservation initiatives, including voluntary agreements to control deforestation and/or hunting, which they define as landscape-level conservation initiatives. They suggest that combined formal and informal conservation initiatives offer important conservation opportunities [21].

Success in conservation projects is commonly measured by quantifying outputs and, preferably, outcomes [22, 23], often measured in non-biological terms. Quantifying success in biological terms in conservation projects can be difficult, as the time frames involved are often longer than many projects, and they can be cost dependent, putting them out of reach of smaller projects [22-27]. In community conservation projects, several previous studies have tried to quantify success in biological terms using measures such as deforestation rates and growth in local species populations, each showing varying levels of success [25, 28, 29].

The current study detects real changes in the population density of *L. flavicauda* at La Esperanza five years after the voluntary pledges to stop hunting and reduce deforestation took place. We analyze these quantitative results within the framework of community conservation theories and methodologies. Our hypothesis is that a reduction of deforestation rates along with an increase in group size and individual densities of *L. flavicauda* will be found where community efforts to control hunting and deforestation have been successful.

Methods

Study Site

We conducted repeat census work of the 2008/09 survey, at the same site near the Centro Poblado La Esperanza, Amazonas department, in northern Peru [10]. The area is composed of ca. 700 ha of disturbed primary forest and regenerating secondary forest, interspersed with pasture (S 05°39′46′′, W 77°54′32′′). The study site is bounded by the main highway, Via Marginal, to the south; to the east and west by pasture and agricultural lands; and to the north it is contiguous with extensive forest reaching to the Rio Maranon (ca. 100 km). Since the last census, very little observable change in forest cover or land ownership has occurred. Three parcels of land (~ 60 ha) were sold or inherited during the intervening period, with some of these parcels being partially cleared. Also, a new dirt road was constructed near the survey site (Fig. 1), increasing rates of land transfers. This has so far not affected the area used in this study.

The site was originally chosen for its location between three protected areas: *Santuario Nacional Cordillera Colan, Bosque de Proteccion Alto Mayo*, and the *Area de Conservacion Privada Abra Patricia-Alta Nieva*. Since the previous census, two additional neighbouring protected areas have been made: *Zona Reservada Alto Nieva* and the *Area de Conservacion Privada Pampa del Burro* (Fig. 1). Terrain in the area is very rugged, with high ridges and deep valleys between 1,800 and 2,400 m. a.s.l. Annual rainfall is ca. 1,700 mm, with a drier season from August to December. Humidity is high year round. Habitat is characterized by primary premontane and montane forests. Heavy logging over the past ~ 30 years means these forests are now dominated by *Ficus* spp. [30, 31] and have a thick mid- and understory with an average canopy height of 15–25 m and occasional emergent trees of 35 m.

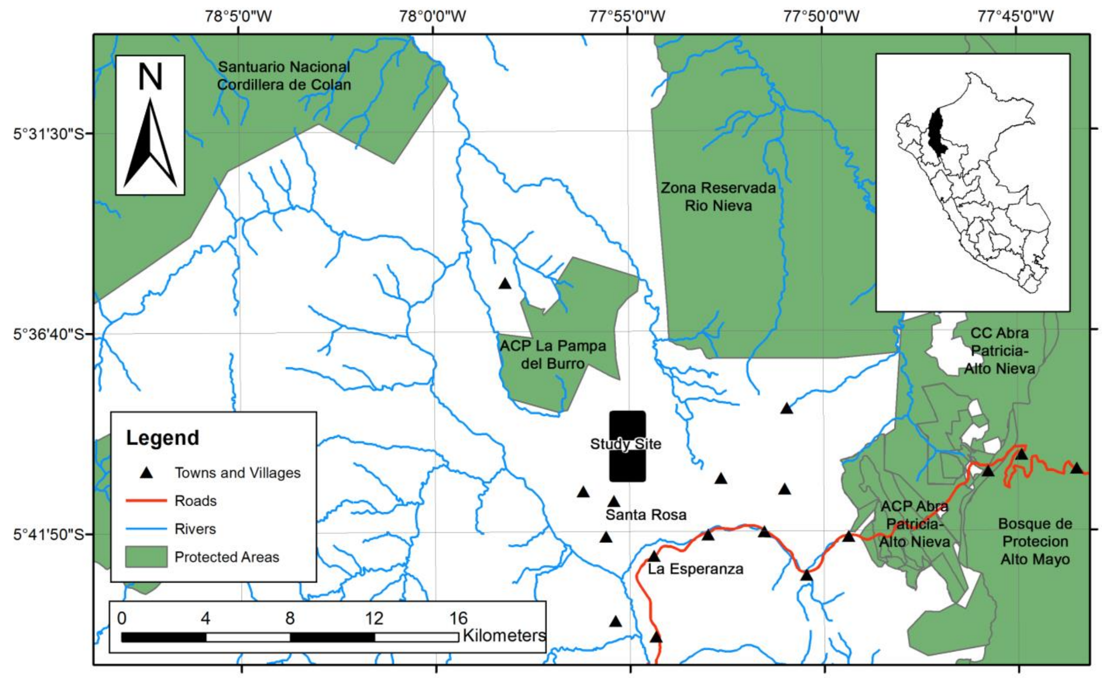

Fig. 1. Location of study site in Amazonas department, northern Peru: showing villages, roads and rivers. Neighboring protected areas are shown to indicate the importance of the area for connectivity and as a buffer to these PA's.

The land is titled to the *Campesino Community* of Yambrasbamba. This single land title covers an area of 80,545 ha. People in the community are of mixed indigenous and European origins who are predominantly subsistence farmers (tubers, corn and beans), with some small scale commercial production (cattle, coffee and rocoto) [32, 33]. According to official community regulations, each community member over the age of 18 is entitled to 50 ha of unoccupied lands within the area bounded by the land title for agricultural use. However, years of illicit land transfers have resulted in an uneven distribution of lands.

Community agreements

We employed commonly used CC methodologies such as local and regional awareness programs, voluntary agreements to control hunting and deforestation, small scale assistance programs and community involvement in research and conservation activities [9, 21, 28], making an effort to comply with the community's requests and ideas of how to achieve conservation rather than trying to impose outside ideas of how conservation should be administered. In 2008, the community asked to formally register a communally run private conservation area in an uninhabited area within the community. We were invited to different villages by local authorities to give conservation talks to explain the benefits of intact forests. Villagers were asked to vote for and sign voluntary pledges to set up systems of internal control of deforestation and hunting. Pledges were updated and re-signed whenever community authorities felt it was needed or when we requested. These conservation pledges and internal controls did not include any direct economic incentives or dedicated vigilance activities.

Voluntary pledges to not hunt threatened species were signed with the five annexes of the community closest to the study site, as well as in the community's general assembly. Agreements were made with the 11 land owners in the study site to allow transects to pass through their lands. Additionally, when land ownership had changed hands, permission was sought and granted by the new owner to continue our work.New land owners also signed the voluntary pledge in whichever village had jurisdiction over the lands. No direct economic incentives were provided to community members, but 17 local guides were rotationally employed as field assistants for field surveys as well as guides for tourists visiting the area. All field assistants and guides were selected from among the landowners or their relations.

Density Estimation

We conducted 13 months of field surveys, from May 2012 to February 2013, and April to June 2013. To make results from this survey comparable to the 2008-09 surveys, we replicated the same methods [10], reopening the four previously used transects. During the intervening years there were a number of landslips and changes in ownership, but minimal alterations in transect location were necessary (Fig. 2). We used a total of 9.1 km (Table 1) of transects. Transects radiated from a central camp at ca. 90° angles, with ca. 300 m between the camp and the start of the nearest transect. We measured and tagged transects every 50 m with high-visibility flagging tape. We walked transects in pairs of trained observers comprising one researcher and one local field assistant. Field trips lasted five days and were repeated every two weeks for the length of the survey. Each transect was walked twice on each field trip, once between 07:00 and 12:00 h and once between 11:00 and 16:00 h, with at least 24 hours between repeat walks on the same transect. Transect walks interrupted by heavy rains were abandoned, leaving an uneven sampling effort between transects. In total 329,150 m of reliable transect walks were completed (Table 1).

Table 1) Transect lengths, sampling effort and detections during this survey.

Transect	Length (m)	Number of Walks	Sampling Effort (m)	Total Number of Detections*
B1	3,000	43	116,000	52
B2	1,750	39	69,050	13
B3	2,300	35	76,600	28
B4	2,050	36	67,500	24
Total	9,100	153	329,150	117

*Total number of sightings including audio and discarded detection events

We made repeat walks to maximize sampling effort on each field trip. Transects were walked at a maximum speed of 1.0 km/h (Average 0.9 km/h) to minimize background noise and increase detection probabilities. We did not include in the census data we collected on return walks, but we did use group counts to record group composition and calculate average group size for the area. On each transect we recorded the following data: weather conditions, species identity, group size and composition (we defined categories as adult male, adult female, juvenile male, juvenile female, undifferentiated juvenile, and non-locomoting infant), location of detection along the transect, and perpendicular distance (PD) to first animal sighted. We allocated ~ 15 min (Avg 7 min) to obtaining group counts to gather accurate group spread estimates for use in adjusted strip width estimates [34]. Incomplete or inaccurate group counts and group spread estimates were discarded and replaced by the mean from all reliable counts during analyses. Single individuals are uncommon in the population and were not included in analysis, as we may have missed them on or near the transect line. We used χ^2 tests to check for bias in detection between observers, field assistants, transects, month, and weather conditions.

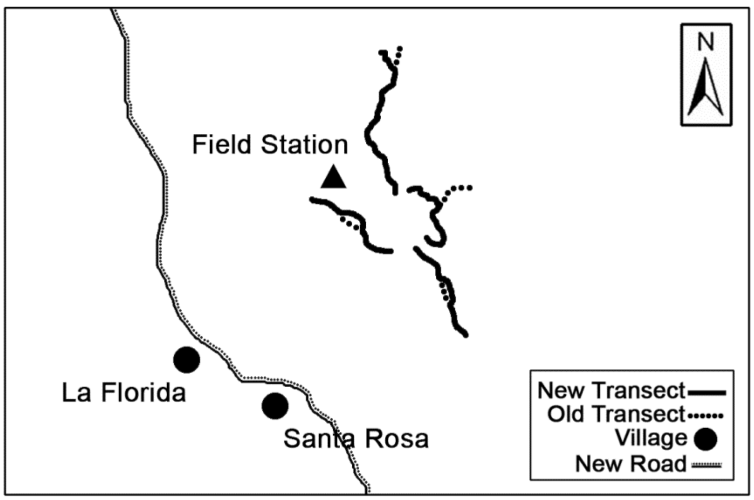

Fig. 2. Transects used in this study (dashed lines indicate changes from previous study), showing neighboring villages and the path of the new road built between survey periods.

As with the 2008-09 survey, we added an estimate of group spread to PD measurements to avoid overestimation of densities [35, 36] and right truncated detections from >100 m.. When possible we estimated group spread at each detection event. This differed from the 2008/9 survey when we did not collect data on group spread during detection events as collecting this data could have violated assumptions of transect methods [35]. We made these additional measurements to increase accuracy of density estimates. Also, the groups at the survey site are now habituated to the presence of researchers, reducing the likelihood of alarm calls or other behaviors affecting detection possibilities farther along the transect. We used the estimated radius to calculate adjusted PD measurements by adapting the method of Whitesides et al. [34]:

$$P' = PD\left(1 + \frac{r}{S}\right)$$

Where PD = perpendicular distance to first individual sighted, S = observer to first individual distance, r = one half mean group spread, P' = perpendicular distance from transect to group center. When the first individual sighted was directly over the transect, i.e., ; = 0°, θ = 90°, PD = 0, X = 0, then P' = 0. We used the transect-width estimation method of Whitesides et al. [34] to obtain an estimate of effective distance. This method has produced good estimates when tested against primate populations at known densities [34]:

$$D = \frac{Nt}{Nf} FD$$

where Nt = total number of sightings, Nf = number of sightings at less than half the fall-off distance (calculated as the 10-m interval at which the number of sightings was half or less than that of the previous interval), FD = fall-off distance, and D = effective distance. We then estimated the area sampled using the equation:

$$A = 2(1/2S + D)Lt$$

where S = estimated group spread in km, D = estimated effective distance, Lt = total sampling effort, and A = area sampled. We calculated group density using the equation:

$$Group\ density = \frac{Gt}{A}$$

where Gt = total number of sightings and A = estimated sample area.

We compared results from density estimates, group sizes and group compositions with results from previous surveys using tests with Yates correction for 2x2 contingency tables to see if observed differences were significant.

Forest cover change mapping

We estimated changes in land cover over the period between surveys using high resolution satellite images for the years 2007 and 2013. For the 2007 period we used a LandSAT 5 TM (Thematic Mapper) image, and for 2013 we used a LandSAT 8 OLI (Operational Land Imager) image, both at 30 x 30 m resolution (both Path/Row 009/064). The LandSAT 5 image was chosen to avoid problems with data gaps in the SLC-off (Scan Line Corrector) LandSAT 7 images for this year. All data were projected on UTM 18S (datum WGS84). A major challenge for remote sensing in montane forest areas is the level of continuous cloud cover [37]. We selected images that had < 20% cloud cover, as 100% cloud free images were not available for these time periods. Prior to analysis we checked both images for positional error, but georectification was not necessary as error between the images was less than one pixel (error ~ 15 m). We then made a cloud cover mask combining both years, which was then applied to both images. Using the Image Classification tool in ArcGIS 10.0 with Spatial Analyst extension [38], pixels in the 2007 image assigned one of seven categories based on a band 3, 4, 2 false color image and an NDVI (Normalized Difference Vegetation Index) using a band 3, 4 (Red, Near infra-red) combination: Forest; Pasture; *Purma*; Urban; Mixed deforestation; Cloud and Shadow. Following Wyman and Stein [39] we used a hybrid supervised/unsupervised approach using Gaussian Maximum Likelihood technique with 30 training samples for unsupervised classification. We then visually and ground truthed estimates based on our training samples, GPS points, and knowledge of land uses in the study area to correct any anomalies in land cover change estimates from image classification. The resulting layer was then overlaid on the 2013 image, and we carried out a supervised classification of newly deforested areas. This was again visually and ground truthed based on GPS points and our knowledge of land use changes in the area.

To investigate the effect on our population density estimates of possible in-migration of outlying groups and individuals of *L. flavicauda* from newly deforested areas and/or greater hunting pressure in neighboring areas, we used two thresholds to define distances of possible influence: low and probable. We searched the literature for known dispersal distances from natal groups of Ateline primates to estimate possible distances for migration into our survey area. Di Fiore *et al* [40] cite a distance > 1 km from observations of two radio-collared individuals (*Lagothrix poeppigii* and *Ateles belzebuth* respectively). Pope [1989, cited in Di Fiore *et al* [40] recorded un-equal dispersal distances for male and female *Alouatta seniculus* of between one and six home range diameters. We calculated the area of low possible influence using a 10 km circular buffer around all transects, based on ~ 7 home range diameters of *L. flavicauda* groups from published data recorded at the study site [41]. Similarly, we calculated an area of probable influence of 800 m, ~ 2 home range diameters. The cloud free land cover estimates were then clipped to these areas, and we calculated the areas in the two remaining land cover classes. We then used χ^2 tests to examine differences in land cover between the 2007 and 2013 survey periods.

To compare deforestation rates among our study site, outlying areas, and the regional and national averages, we calculated annual deforestation rates from official figures [42, 43] for Amazonas and San Martin Regions of Peru, which cover the majority, ~ 90 %, of the species range [44]; we then compared these with our estimates from the study site using χ^2 tests.

Results

Between the two census periods, behavioral work on *L. flavicauda* was carried out and a small, unstable stream of tourists arrived to the area, mainly to see *L. flavicauda* and the endemic long whiskered owlet (*Xenoglaux loweryi*); therefore, we had presence in the area 10-15 days each month, and there was never a long period, > 2 months, when we did not visit the area. We are only aware of one case of hunting of *L. flavicauda* around the study site since the start of the project. In 2008, a female was shot and her infant was taken as pet. The infant was later rescued by our team and given to a local rescue center.

The project also yielded the creation of a Private Conservation Area (ACP), La Pampa del Burro, on community lands and managed by a committee of community members. The ACP is < 1 km north of the census survey area. It covers 2,776 ha, composed of white sand forest with smaller areas of montane forests that are habitat for *L. flavicauda.* The area was recognized in perpetuity after a majority vote of community members passed tTable 2he decision. The creation of the reserve can be seen as another measure of success for this project. Deforestation in the conservation area was only 4.4 ha, or 0.16%, between 2007 and 2013, equivalent to 0.026% annually.

Density estimates

We detected *L. flavicauda* 116 times during transect surveys, 53 of which were visual detections, 44 audio detections, and 19 indirect detections from food residue and feces. Excluding indirect and solely audio detections (audio detections not followed by visual detection), a total of 73 encounters were used in density estimates. Average group size from 58 reliable counts, including census walks and return walks, was 11.32 (min 2, max 22, SE 4.36). We recorded a mean of 2.7 (min 1, max 7) adult males, 3.5 (min 1, max 9) adult females, 3.2 (min 1, max 7) juveniles, and 2.1 infants (min 1, max 5). On two occasions we observed lone individuals, and as in the previous survey lone individuals were not considered for density estimates. We found no observer bias in detection rates between investigators (χ^2= 10.13, df = 17, p = 0.89) or local field assistants (χ^2 = 12.55, df = 10, p = 0.25). We also found no significant difference in encounter rates between transects (χ^2 = 0.55, df = 3, p = 0.194), weather conditions (χ^2 = 0.04, df = 1, p = 0.83), or month (χ^2 = 5.02, df = 10, p = 0.89).

We estimated group spread at a diameter of 29.83 m (SE15.49). This gave an effective distance for transect-width estimation method of 21.8 m, and estimated densities of 1.28 (SE 0.2) groups/km² and 14.45 (SE 3.3) individuals/km². Group and individual densities increased by 18.8 and 35.9 %, respectively. We estimated the total number of groups that include all or part of their territory within the 700 ha of the study site, using density estimates obtained from the line transect survey at 8.7 groups.

Tests for differences in *L. flavicauda* group size, composition and population densities between the 2008/09 survey and the current survey showed no significant difference in group densities, individual densities, number of adult males and number of adult females (Table 2). Statistically significant differences were observed in group size, number of juveniles, and number of infants (Table 2). The difference in increase between group and individual densities was also significant (χ^2 = 5.35, df = 1, p = 0.02)

Table 2) Mean population densities and group compositions from each census year.

	2008/2009	2012/2013	Change (No/%)	P
Group density	1.04	1.28	+0.24/18.8 %	0.87*
Individual density	9.26	14.45	+5.19/35.9 %	0.28*
Group size	8.9	11.32	+2.42/21.2 %	0.005⁺
Adult males	2.3	2.8	+0.5/17.8 %	0.062⁺
Adult females	2.3	3.5	+1.2/34.2 %	0.156⁺
Juveniles	1.5	3.2	+1.7/53.1 %	0.019⁺
Non-locomoting infants	0.4	2.1	+1.7/80.9%	<0.001⁺

*χ^2 test, ⁺ Mann-Whitney U test

Forest cover change mapping

Using a maximum home range estimate of 174 ha from published estimates from our survey site [41], we generated a buffer of ~ 10 home range diameters (10,000 m), giving a 37,860 ha polygon around the survey site, an area of ~ 218 home ranges (Fig. 3). Our estimate of deforestation for 2013 was 9,959 ha, representing an increase of 0.52 % (Table 3) using a LandSAT 8 image (Fig. 3). Using the two home range buffer generated a polygon of 979 ha, an area of ~ 5.6 home ranges. Our deforestation estimates for 2007 and 2013 were 87 and 93 ha respectively, representing an increase of 0.61 % (Table 3). Using χ^2 tests, the change in land cover in our estimated area of low influence was not significant (χ^2 = 0.99, df = 1, P < 0.32). Using the probable influence area, there was also no significant difference found in the amount of deforestation between 2007 and 2013 (χ^2 = 0.1, df = 1, P = 0.75). Annual deforestation rates over both areas of influence estimate were 0.09 % and 0.1 %, respectively.

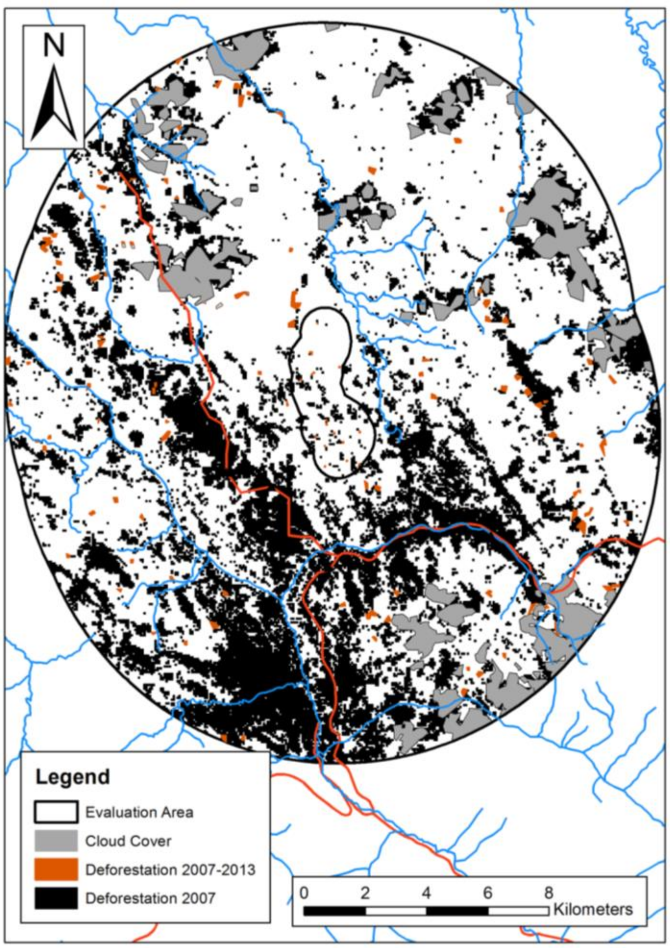

Fig. 3. Map of landcover change in the area surrounding the study site between surveys. Map shows the two buffers used to represent different levels of influence on local populations of *Lagothrix flavicauda*.

Annual deforestation rates for Amazonas and San Martin over the period 2005-2011,calculated from official figures [42, 43], were 0.18 % and 0.62 %, respectively, giving a 0.4% average for the range of *L. flavicauda* . Differences between annual deforestation rates in Amazonas/San Martin and th e two areas we examined (maximum and minimum areas of influence) were all non-significant ($\chi^2 > 0.05$).

Table 3) Variable deforestation estimates between 2007 and 2013.

	10 home range buffer (ha)	2 home range buffer (ha)	Bi-regional average
2007	9,761	87	-
2013	9,959	93	-
Increase (ha)	198	6	-
Increase (%)	0.52 %	0.61 %	-
Annual deforestation rate	0.09 %	0.1 %	0.4%

Discussion

The results of this study showed increases in both individual and group densities over those found in the previous 2008/9 survey [10]. Although neither change was significant in itself, there was a significantly greater increase in individual densities than in group densities. The overall average group size increase was also significant. When changes in individual age-sex classes were examined separately, significant increases were only found in the juvenile and non-locomoting infant categories. These increases suggest that the majority change is from natural population increase and not due to in-migration of individuals or groups from outside the study area. By replicating as exactly as possible the methods of the previous survey [10], we have traded increased comparability for possible improvements in survey methods. This was necessary because variation in census results are typically due to differences in methodologies [45].

Assuming observed increases were from natural population growth, an increase of ~ 35% in just five years is high, but possible. Assuming that *L. flavicauda* have reproductive rates similar to other *Lagothrix* spp. and *Ateles* spp., ~ 3 year inter-birth interval [46], the 4-5 year interval between our surveys gives each adult female the opportunity to reproduce one or two times, not including females that reached sexual maturity during the intervening period. Previous work with the *L. flavicauda* at La Esperanza showed a ~ 50/50 male to female ratio and ~ 60/40 skew towards adults in the population [10]. Therefore, one successful reproduction per adult female in the intervening years would lead to a 33% population increase, which is just below the increase observed in this study. Including the possibility of more than one successful reproduction in some females and those females who reached reproductive age in the period between surveys, an even greater increase in population size is possible.

An interesting observation of this study is the increase in group spread recorded in the 2013 survey. This could be because of differences in resource production between survey years due to greater/lower rainfall and/or solar radiation. Such differences could be responsible for the small increase observed in group densities, as larger groups will be more conspicuous, increasing the possibility of detection. However, this will not have an effect on individual densities, particularly within age-sex classes. Surveys from other less disturbed areas have recorded larger groups than those found at our study site, up to 20-30 individuals in the *Bosque de Protección Alto Mayo* [47], up to 18 in *Parque Nacional Rio Abiseo* [11] and up to 15-25 in the Los Chilchos Valley, San Martin [JHM Dignum pers. Comm.]. Similarly we have had un-confirmed reports from many local people during distribution surveys [1, 48, 49] of larger groups being found when areas are first settled, prior to the impact of hunting and deforestation. It is possible that the *L. flavicauda* population at La Esperanza is below carrying capacity and will increase further if hunting controls are continued.

Our analysis of annual deforestation rates in the survey area showed no significant increase in forest loss over either of our influence thresholds. The average annual deforestation rates for our threshold areas were also much lower than the official regional estimates for Amazonas and San Martin (0.18 and 0.62% respectively). Although all observed differences in forest cover and deforestation rates were not significant, deforestation in our area was lower than the average across the species range. This difference is more interesting when put into the local context. In the period between surveys a new road was built bordering the survey site, allowing the first vehicular access to nearby forested areas. Roads are a common cause of deforestation and forest degradation [50-52] through intensified migratory agriculture and logging [53], increased forest fires [54], and wildlife traffic [55, 56]. Humid montane forests are especially vulnerable to the ravages of road construction, placing specialized species at great risk [50]. Studies conducted in the Upper Huallaga river basin have shown a high probability of deforestation in strips of up to 10 km on either side of roads, an effect that only diminishes when valleys are particularly steep [57]. In lower Amazonia, deforestation can reach up to 100 km from paved highways [58, 59]. Similarly, Jerozolimski and Peres [60] found that hunting can occur anywhere within 9 km of any access point. Amazonas and San Martin had already lost the majority of their primary forest cover prior to our work, whereas our survey site still retains 74% primary forest cover.

Shanee e*t al*. [21] describe the difficulties facing local *campesinos* in formally protecting their lands. Because the complexity and expense of requirements set up by the Peruvian government are prohibitive to many rural populations, many local groups turn to informal conservation initiatives as alternatives [21]. Shanee [61] describes *campesino* rationales for conservation initiatives, identifying an appreciation of nature's intrinsic values, religious or spiritual value, aspirations for sustainability, concern for future generations, and the struggle for social justice and recognition as the most common justifications. She found that local communities often take pride and satisfaction in the return of and increases in wildlife as a result of their initiatives.

In a similar project in La Primavera, Peru [21, 61], we have been working on the creation of a 7,174 ha Conservation Concession, Sun Angel's gardens, administered by a local association. In addition to local support of the new reserve, the villagers of the four surrounding villages have signed agreements to control hunting and deforestation in all the surrounding areas, covering ~ 80,000 ha. Local people reported that white bellied spider monkey (*Ateles belzebuth*), which until recently was only found four to five hours' walk from villages in remote areas, can now be found very near agricultural fields just one hour's walk from villages following five years of voluntary hunting controls.

Informal conservation efficiency is hard to measure because of inexact geographic limits and difficulties in long-term monitoring of forest growth and populations of wildlife. Such long-term projects are unfeasible for many NGOs, as funders generally require quick and conclusive results [62-64]. The essence of landscape-level conservation is its large geographical extension and the inclusion of populated areas. It is mainly informal and therefore has no legal standing against national and regional development plans or against continuous immigration to an area. Moreover, it does not offer complete protection for forests and in most cases will not benefit wildlife that need large areas of undisturbed primary forest. It therefore is generally a complementary activity in combination with the creation of better protected, intangible private and state-run protected areas to efficiently protect a range of species [65]. Wildlife can quickly return to non-hunted areas, giving local people a sense of success and pride. This type of conservation also avoids the bureaucratic processes required by the state. Informal conservation initiatives can be implemented on individual, communal or regional levels [21]. They do not require a consensus, bureaucracy, or the cooperation of authorities.

Fig. 4. Clockwise from top right: Adult male *Lagothrix flavicauda* (Photo Credit Shanee /NPC); Panoramic view of cloud forest habitat in the survey area (Photo Credit Shanee/NPC); Local villagers voting in favor of the creating of a communally protected area (Photo Credit Shanee/NPC); Local logger posing next to trunk of a recently felled *Cedrella odorata* (Photo Credit Shanee/NPC).

Implications for conservation

This is one of the few existing studies of the impact of locally run, landscape-level conservation initiatives on local fauna. It shows that low-cost, community-based conservation projects offer valid conservation opportunities for threatened species. Due to the very small range and intensity of anthropogenic threats (Fig. 4) in the densely populated habitat of the Critically Endangered *L. flavicauda*, the efficiency of such initiatives for conserving species within populated landscapes could be the most important factor for the survival of this species.

We urge conservation theoreticians and practitioners to be much more attentive to local conservation rationales and methodologies and work as much as possible with existing cultural organizations, while we hope that funding agencies and the public will be more willing to donate to small scale, local, or locally-focused NGOs.

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