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RESEARCH / INVESTIGACIÓN

Effects of anthropogenic activities on Inca trails network, Machu Picchu historic sanctuary, Cusco, Peru

Luz Z. Peña-Candia[1], Yeny R. Baca-Zans[2], Juan F. Costa[3].

Abstract: *The effects of human activities were evaluated, including width and depth of the roads, amount of solid waste, presence of wildlife (birds and mammals), and vegetation in 35 plots at Inca trail network in Machu Picchu Historic Sanctuary. The evaluations were performed between 2008 and 2010 on three tourist trails: 1) Traditional Inca Trail, 2) Valley trail, and 3) Salkantay trail. The depth of the road showed greater variation in trail 3. The abandoned solid wastes (kg) were: 45.1, 129.8, and 143.8 for 2008, 2009 and 2010, respectively. Plastic wastes were more abundant. Organic wastes (mainly feces) were produced by cattle and horses. Regarding the presence of fauna, the following numbers were registered: 1) 21 species of birds and 3 of mammals on route 1, 2) 18 species of birds and 3 species of mammals on route 2, and 3) 16 species of birds and 1 species of mammal. According to CITES, Puma concolor and Vultur gryphus are listed in Appendix I, and Lycalopex culpaeus is listed in Appendix II. According to the List of Endangered species of Peru, P. concolor is listed as Near Threatened (NT), and V. gryphus is listed as Endangered (EN).*

Keywords: *impacts, variation of the trail, flora, wildlife, Machu Picchu.*

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[1] Biologist, specialist of the Megantoni National Sanctuary, SERNANP, School of postgraduates, San Antonio Abad del Cusco National University (UNSAAC), Peru, lpena@sernanp.gob.pe
[2] Biologist, specialist of the Saqsaywaman Archaeological Park, Directorate of Deconcentrated Culture, – Cusco (PAS-DDC-C), codeyyenybaca@gmail.com
[3] Biologist, Collaborating Researcher of the Entomology Laboratory, San Antonio Abad del Cusco National University (UNSAAC), jfrancosta@gmail.com

INTRODUCTION

In recent decades tourism has become one of the economic activities that have generated the highest expectations, both at the level of local and regional governments, as well as in the population in general. Economic systems in different countries, in different levels of development put special interest in tourist activity (Tinoco, 2003). In Peru, tourism was considered to be the second economic activity of the country, relegating fisheries and agriculture as the activities with greater economic benefits (RPP, 2014). However, it is predicted that tourism will be the first economic activity of the country for 2035 (El Comercio, 2013).

Tourism is mainly developed in natural scenarios and in the case of urban areas it includes cultural resources, whose vulnerability to the massive influx of visitors is very high (Van de Meene, 1992). Among the most common environmental impacts that have been identified in activities linked to tourism, eutrophication of lakes and lagoons, alteration of water bodies, deforestation of hillsides, noise pollution, identity loss of the landscape, garbage on roadsides and roads, and indiscriminate extraction of local flora can be mentioned (Otero & Rivas, 1995).

Protected natural areas are part of the most important tourist attraction in Peru. Among these, the Machu Picchu Historic Sanctuary (MHS) hosts tourist attractions both natural and cultural. The Inca trail network is a complex of trails with a total of 43 km that lead to the Inca Citadel in Machu Picchu. In this network of roads, numerous archaeological remains can be observed, as well as scenarios of scenic beauty and wide biological diversity (Shoobridge, 2004). The MHS was established in 1981 and UNESCO declared it a World Heritage Site in 1983. For MHS, Shoobridge (2004) mentioned the main threats, among which, excessive tourism, transmission lines of energy, generation of solid waste, forest fires, unsustainable agriculture, introduction of exotic species and lack of alternate routes and studies of access to the Inca Citadel can be mentioned.

The use of indicators allows preventive and/or corrective measures against the impacts that can be produced in natural spaces, before these damages are irreversible. Likewise, at allows monitoring these indicators ant the variation they experience in the short, medium and long term due to human activities (Stankey et al., 1985). In this context, the following objectives were proposed: 1) evaluate the variation in the wide road (width and depth), 2) determine the amount of solid waste abandoned (organic and inorganic), and 3) determine the presence of birds and mammals in the Inca trail network of MHS.

MATERIALS AND METHODS

Selection of the evaluation area

A total of 35 plots were established in three existing routes in the Inca trail network in MHS: 1) traditional Inca trail, 2) valley floor, and 3) Salkantay. These plots were established considering the accessibility in the evaluation routes. 18 plots were installed on the traditional trail, 9 on the valley floor trail and 8 on Sulkantay trail (Table 1).

Tabla Nº 1. Ubicación de las parcelas de evaluación.

Route	Plot	Plot name	East UTM	Nort UTM	Altitude (m)
	1	Yahuarhuacca	783217	8537272	2690
	2	Mescay	779702	8535344	2653
	3	Tarayoc	778418	8534190	2726
	4	J´atunchaka	776968	8532830	2879
Traditional	5	Yuncachimpa	775139	8532656	3276
	6	"Uncas" forest	774497	8533334	3520
	7	Llulluchapampa	773485	8534036	3912
	8	Warmihuañusca-Pacaymayo Alto	771695	8535194	3842
	9	Cochapata	770482	8536436	3937
	10	Yanacocha	769693	8536514	3710

	11	Conchamarca-Chaquicocha	768950	8536778	3545
	12	Chaquicocha-Phuyupatamarca	768416	8537380	3631
	13	Phuyupatamarca-Wiñaywayna Tunnel	766733	8539260	3184
	14	Intipata Tower	766502	8540403	2862
	15	Torre Wiñaywayna	766790	8540552	2836
	16	Cascarilla Forest	766812	8541880	2647
	17	Fifty steps	767363	8542490	2508
	18	Pachamama Ciudadela	766838	8542666	2647
Piso de valle	19	Q'ente	776724	8536963	2480
	20	Torontoy	776106	8538479	2444
	21	Pampacahua	775104	8539277	2356
	22	Pacaymayo Bajo	773488	8539972	2345
	23	Pisonay Tunnel	772346	8541373	2318
	24	Km. 102 Tunnel	770403	8541838	2255
	25	Chachabamba –Tower	769535	8540736	2260
	26	1° Choza - 2° Choza	768178	8540590	2280
	27	Catarata Wiñaywayna	767122	8540042	2590
Salkantay	28	Salkantaypampa	764037	8520640	4162
	29	Japanese Pampa	765196	8522439	4764
	30	Abra Inkachiriasca	766845	8522019	4529
	31	Sisaypampa	771488	8524069	4067
	32	Lower Pampakahuana	774076	8525150	3827
	33	Churumayo	775503	8527035	3607
	34	Paucarcancha	776145	8529181	3342
	35	Wayllabamba	776218	8530653	3100

Selection of parameters

The parameters for measurements were chosen based on the Limits of Acceptable Change (LAC) (Stankey et al., 1985), which allow establishing priority evaluation parameters and the impact on the main biotic and abiotic factors in areas with tourist activity.

a) Variation of width and depth of the trail

This indicator shows the direct effect of the movement of tourists within the Inca trail network, as well as settlers and pack animals that perform the transfer of materials, equipment, goods and services that are used in tourism-related activities. Likewise, the variation in width and depth of the road is attributed to the consequence of natural actions, such as wind and rain.

b) Amount of abandoned solid waste

The amount of organic and inorganic abandoned waste is beyond the control and collection carried out by competent entities that perform that task. Abandoned waste was registered inside the evaluation plots. This indicator shows a negative effect of human activities.

c) Vegetation

Vegetation is affected by human activities mainly when the occupation of the area is produced by foreign objects (solid waste, organic and inorganic). The characterization of the vegetation was performed and the floristic conformation of the evaluation plots was determined.

e) Wildlife

Tourist activity, due to the fluid traffic of people and domesticated exotic animals, as well as illegal practices (hunting, collection) may cause the decline of populations of different species, whether by death, migration or extraction. The presence of birds and mammals was considered during the evaluation, since they present variation in the

frequency of species sighting, as well as new records of species for the evaluation plots.

Procedure

Data collection of the three routes was carried out between 2008 and 2010, in June, July and August, performing the evaluation of the route in the same months.

a) Variation of width and depth of the road

Transects of 50 m ach were installed. 18 transects on route 1, 2 transects on rout 2 and 8 on route 3. In each of these transects, width and depth of the road were measured at distance points every 10 m (o, 10, 20, 30, 40 and 50 m), totalizing 6 measurements per transect. Each point was marked by stakes during the three years of evaluation. In the case of depth of the road, left, right and central sides of the road were measured, using a ruler as a level guide to measure the depth in the central part of the road. In the case of the variation of width and depth of the road, comparisons were made between evaluations of width and depth of the road by evaluation route in the 135 plots (average per plot).

b) Amount of abandoned solid waste

When using the 35 transects installed and distributed in the three evaluation routes, a 10 m projection was performed to both sides of the transect (50m x 20m, 10 m on each side of the road). Here, an exhaustive search for solid organic and inorganic waste was performed to subsequently, after being collected; all waste was segregated and weighed considering the mass of each type of waste.

The amount of abandoned solid waste in the 35 plots was determined, as well as the variation in total weight of abandoned solid waste throughout the evaluation period. Likewise, a comparison of the evaluation was made between the total weight of solid waste abandoned I the routes with the total weight of solid waste that are evacuated from the routes of the Inca trail network.

c) Vegetation

In the 35 evaluation plots, the species were identified and the abundance of the most representative species was determined. In the required cases, photographic captures were performed in order to identify the plants in the laboratory.

d) Wildlife

Direct observation techniques are the most appropriate to study large terrestrial mammals or small mammals (arboreal or terrestrial), cataloguing as much specimens as possible (Emmons, 1999). To determine the presence of some species of birds and mammals, the utilization o the direct observation methodology was considered (observation of the individual) and indirect (record of indications such as footprints, excreta, hairs and others).

In the case of wildlife, lists of species per plot were performed, and the review of the conservation status was also performed in the lists of the Convention on International Trade in Endangered Species of Wild Fauna and Flora – CITES (CITES, 2015) and the "Supreme Decree approving the updating of the list of classification and categorization of threatened species of legally protected wildlife" Decreto Supremo N° 004-2014-MINAGRI (El Peruano, 2014).

RESULTS AND DISCUSSION

Width of the road

The width of the road in the traditional route is greater than in the other two routes, during the three years of evaluation (Table 2).

Table 2: Width of the road in cm (average ± standard error)

Evaluation Route	Evaluation year		
	2008	2009	2010
Traditional Inca trail	159.3 ± 8.2	162.8 ± 8.2	160.0 ± 7.1
Valley Floor	101.2 ± 11.8	103.1 ± 12.1	95.9 ± 12.2
Salkantay	105.5 ± 9.1	107.8 ± 9.1	102.2 ± 11.2

Route 1 presented the widest road, because the Piscacucho-Wayllabamba- Pacaymayo Alto- Phuyupatamarca- Wiñaywayna- Machu Picchu route is the one where the traffic of people is fluid and more people are present (tourists, supporting staff, tour guides). Likewise, the entry of greater number of organized groups is observed and in addition to this, the organized groups that enter via route 3(Salkantay) from the Wayllabamba sector follow the same route than those that entered via route 1 (traditional Inca trail). Alfaro (2004) reported that the width of the road is more affected on route 1 (sector Piscacucho-Wayllabamba), reaching an increase up to 60 cm. This extension is due to the fact that visitors avoid some of the obstacles such as high stands, and begin their walk along the side of the road. To this, it should be added that porters during their tour, give way to tourists and guides, standing on both sides of the road.

On route 1, the variation in the width of the road can be related with the number of people that registered their entry. Thus, in 2008 entered 151,148,405 people and the width of the road was 159.3 cm ± 8.2; in 2009 entered 151,322 people and the width of the registered road was 162.8 cm ± 8.2, decreasing up to 160 cm ± 7.12 in 3010, year in which 135,604 people entered. Overall, apparently there were no differences in the variation of the width of the road on route 1 between the three years, though plots 11 and 14 presented more noticeable differences. Plot 11 (Conchamarca- Chaquicocha) is located between the complexes of Conchamarca and Sayacmarca, being this of high traffic of tourists and guides. On the other hand, plot 14, Intipata Tower is also constantly traveled by staff of EGEMSA (Machu Picchu S.A. Electricity Company) for the maintenance of high voltage towers located in the area.

On route 2, the width of the road between the three years of evaluation has a variation range of ± 3 cm, and the number of people who entered was 13, 243; 12,465 and 11,665 in 2008, 2009 and 2010, respectively. In addition, in 2009 the NC staff (now Cusco/DDC-C Deconcentrated Directorate of Culture) carried out maintenance works in its Control Post in the Lower Pacaymayo sector. For this reason, the traffic of people on this route increased, being registered in 2009 the width of the road with a higher value of 162.8 cm ± 8.2. It should be noted that this activity is directly related to the tourism in MHS since the control post of the DDC-C serves to perform register, monitoring and control of the tourism activity. The variation of the width of the road practically remained constant from plot 19 to plot 24, whereas from plot 25 to plot 27, the width of the road decreased. Plot 26 was the only one that presented noticeable differences, since reforestation works were carried out in this sector by SERNAP personnel in 2009 and a significant decreased in the width of the road was observed.

On route 2, the variation of the width of the road in the three years of evaluation ranged from 107.8 cm ± 9.1 in 2009 as maximum value and 102.2 cm ± 11.2 in 2010 as a minimum value. The difference of 5 cm reflects that there is a variation in the width of the road due to the traffic of people. Regarding the measurement of the width of each plot along the entire trail, the width remained constant in plots 28, 29 and 32 and an increase in plot 32 was observed, unlike plots 31, 33-35 where there was a decrease in their measurements. Plots that showed marked differences were plots 33 and 34. Plot 34 (Paucarcancha) and plot 33 (Churumayu) decreased the width of the road due to a climatic phenomenon that occurred in early 2010, where rains intensified and there were small landslides. Later, the roads of those sectors were restored.

Depth of the road

The depth of the road on Salkantay trail is greater than on the other two trails during the three years of evaluation. The variation of the depth of the road remained without noticeable increases or decreases (Table 3).

Table 3: Depth of the road in cm (average ± standard error)

Evaluation route	Evaluation year		
	2008	2009	2010
Traditional Inca trail	3.23 ± 0.42	3.56 ± 0.25	3.64 ± 0.14
Valley floor	3.34 ± 0.42	3.33 ± 0.45	3.60 ± 0.46
Salkantay	3.75 ± 0.42	4.14 ± 0.42	4.22 ± 0.41

The measurement of the depth of the road remained almost without changes compared to that reported by Alfaro (2004), since the variations were less than 5 cm in most plots. On routes 1 and 3, a successive increase in soil depth was observed, though a noticeable variation was not perceived. Plot 7, located in the Llulluchapampa sector is part of the tour performed by the camelid cattle of one possessory of the sector. Plot 8 (located in the Warmihuañusca – High Pacaymayo sector) and Plot 10 (located in the Yanacocha sector) have a steep slope. Likewise, along the trail receives filtration water. Finally, Plot 15 in the Wiñaywayna sector receives constant maintenance by being closet o the DDC-C post.

On the other hand, on route 2 the variation of the depth of the road has no significant variations in the three years of evaluation. Plots from 19 to 36 increased in depth, whereas the only Plot that decreased in depth was plot 27.

For route 3, depth is greater compared to the other two routes, in the three years of evaluation. This is a consequence of the soil runoff due to a constant rainfall and the decompactation of the soil, as a result of agricultural activities. In this route it is observed that the structure of the slopes is being affected by the loss of the vegetal cover and the introduction of exotic species that destroy the soil protection resources (Cárdenas et al., 2004) causing erosion. Plots from 29 to 32 showed in increase of almost 1 cm per evaluation year. Plots 28-33 and 35 increased depth in 2008 and 2009 and subsequently decreased it in the 2010 evaluation.

Abandoned solid waste

SERNANP carries out the registration of solid waste generated by tourists as a product of the tourist activity (waste from tourism companies) and in the Inca trail network. On the other hand, waste that escapes this control (abandoned solid waste) represented a low percentage compared to the total registered solid waste (Table 4).

Table 4: Solid waste in kg (managed vs. abandoned)

Evaluation route	Evaluation year					
	2008		2009		2010	
	Managed solid waste	Abandoned solid waste	Managed solid waste	Abandoned solid waste	Managed solid waste	Abandoned solid waste
Route 1	7700.000	32.306	6800.000	55.166	7500.000	57.045
Route 2	7800.000	1.916	7200.000	22.238	7500.000	13.040
Route 3	8300.000	10.920	6800.000	52.400	9000.000	73.709
TOTAL	23800.000	45.142	20800.000	129.804	24000.000	143.794

The weight of abandoned solid waste is not too high, but the visual impact generated on the landscape is considerable, since the largest amount of solid waste has an inorganic origin, such as plastic bottles, plastic bags, candy and cookie wrapper, and other waste of organic origin, such as paper and cattle feces among others (Table 5).

Table 5: Abandoned solid waste (in kg) registered by their nature.

Origin	Type	Route 1			Route 2			Route 3		
		2008	2009	2010	2008	2009	2010	2008	2009	2010
Inorganic	Plastic	1.336	4.416	1.700	0.309	1.148	0.011	0.223	0.946	0.564
	Fabric	0.107	1.294	0.000	0.010	0.050	0.000	0.031	0.372	0.049
	Glass	0.227	0.800	0.000	0.000	0.000	0.000	0.000	0.000	0.019
	Others	0.415	0.038	0.000	0.087	0.201	0.000	0.098	0.720	1.681
	Cattle	12.682	34.560	33.700	1.025	11.124	8.824	4.649	27.070	38.895

	Equine	16.053	8.756	9.770	0.316	9.700	4.190	5.286	18.714	32.182
	Llama	0.117	4.600	11.500	0.000	0.000	0.000	0.091	2.600	0.000
Oragnic	Sheep	0.001	0.000	0.000	0.000	0.000	0.000	0.443	0.576	0.240
	Dog	1.039	0.163	0.130	0.036	0.000	0.000	0.055	0.000	0.000
	Pork	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.100	0.064
	Human	0.023	0.000	0.000	0.013	0.000	0.000	0.000	0.100	0.000
	Wild bird	0.013	0.000	0.000	0.080	0.004	0.004	0.032	0.200	0.000
	Paper	0.293	0.539	0.245	0.040	0.011	0.011	0.012	0.002	0.015
TOTAL		32.306	55.166	57.045	1.916	22.238	13.040	10.920	52.400	73.709

Vegetal characterization of the plots

A general characterization of the vegetation in the evaluation plots is presented in Table 6.

Table 6: Characterization of the evaluation plots.

Plot(s)	Vegetation characterization
1	Shrubby forest with: Berberis sp, Senna birrostris, Lovivia sp., Opuntia ficus-indica, Opuntia flocosa.
2	Riparian forest with: Caesalpinia espinosa, Alnus acuminata, Mauria ovovata, Dodonaea viscosa.
3, 4	Shrubby forest: Dodonaea viscosa, Mintostachis setosa, Barnadesia horrida, Acalipha sp., Tecoma sambucifolia, Inga sp.
5	Riparian forest with: Berberis sp, B. horrida, Baccharis sp., Acalipha sp., Salvia sp., Mintostachis sp.
6	Forest of Myrcianthes oreophila (uncas forest).
7, 9 y 10	Grassland with Baccharis peruviana, Erica sp, Alchemila sp., Stipa ichu.
8	S Shrubby forest with species of malvaceae, rosaceae, asteraceae, poaceae, scrophulariaceae.
11-18	Forest and shrubby forest with Chusquea sp., Buddleja coriacea, Cyathea sp., Ericaceae, Polylepis, Escallonia, Weinmania, A. acuminata, Speromeles lanuginosa, Mellinis multiflora.
19	Shrubby forest with domain of Dodonaea viscosa, Caesalpinia spinosa, Spartium jumceum, Baccharis latifolia, Stipa sp.
20	Riparian forest, surrounding vegetation: C. spinosa, Furcraea andina, Oreocallis grandiflora, D. viscosa, Berberis sp., Rubus sp., Mauria ferruginea.
21	Riparian forest of Clusia with surrounding vegetation of Oreopanax sp., melastomataceae.
22	Shrubby forest with D. viscosa, area reforested with Podocarpus glomeratus.
23	Shrubby forest with Erytrina falcata with abundant presence of Myrcine latifolia.
24	Shrubby forest with presence of reforestation
25	Shrubby forest with abundant presence of figs in the undergrowth
26, 27	Forest with presence of Alnus acuminata, soil covered with Mellinis multiflora.
28-31	Grassy scrub (Stipa ichu, mainly).
32, 33	Shrubby forest with Gynopsis, Oreopanax, Rubus, Speromeles, Syphocamphyllus, Berberis, Barnadesia, Ambrosia, Baccharis peruviana.
34	Riparian forest with: Berberis, Myrcine, Speromeles, Cytharexilum, Myrcianthes, Clethra, Sambucus, Oreopanax, Baccharis, Mauria, Piper, Vallea, Alnus.
35	Shrubby forest with: Mauria, Acalipha, Fuchsia, Escallonia, Barnadesia, Opuntia, Echinopsis, Lovivia, Trichocerius.

On route 1, vegetation is made up by shrubby forests (plots 1 and 14) and riparian thickets (plots 2 - 5, 8, 17 and 18), grasslands (plots 9 and 10), high Andean forests (Polylepis sp., Plot 13) and cloud forests (plots 11, 12 and 16). Riparian forests are associated with the Vilcanota/Urubamba River basin and the Kusichaka River basin (from the locality of Piscacucho, km 82 of the railroad, following to the locality of Wayllabamba, on the left bank of the Vilcanota/Urubamba River. The presence of grassland in this route is due to the increase in altitude and the decrease of other plant species towards the sector of Llulluchapampa (3,912m) and the proximity of the Abra Warmiwañusca (4,200m). Here, monitoring plots were established, being Festuca dichoclada and S. ichu the predominant species. After the High Pacaymayo and Abra Runkurakay sectors (3,800 m) vegetation tends to be more forested and the presence of cloud forests can be observed. Between plots 12 and 18 are the Phuyupatamarca and Wiñaywayna sectors. In the Wiñay Wayna area, the presence of infrastructure for services and other facilities have led to the flora and wildlife being strongly altered, especially for the enabling of areas for camps and the subsequent movement of soil and the removal of vegetation.

Route 2 typically presents plant formations of riparian and bushy plant formations (located in the banks of the Vilcanota/Urubamba River), represented by species such as S. junceum, C. spinosa and F. andina (plots 19 and 20). Continuing along the Vilcanota River, plots in the riparian and scrub forests were installed. These plots had abundance of Clusia sp., E. falcata, and reforestation species (plots 21-25). Passing the Chachabamba sector, plots 26 and 27 were located, which presented A. acuminata as the dominant tree species.

Route 3 initially presents plots with grass-like vegetation (due to the altitude of the Salkantay Snowy Mountain, abra Inkachiriaska of 5,200 m) where plots 28 and 32 presented this type of predominant vegetation. Descending towards the locality of Paukarcancha to continue to the locality of Wayllabamba (on the right bank of the Kusichaka River), plots 33 to 35 are made up by riparian bushy vegetation.

The MHS has great diversity of plant formations due to the altitudinal and climatic difference (Galiano, 2000; Galiano y Tupayachi, 2002; Shoobridge, 2004). Likewise, due to these altitudinal characteristics, these plant formations can be differentiated by the presence of ecotones among them (Baca-Zans, 2008).

The current characterization of the evaluation plots is in accordance with results obtained by Peña-Candia (2008), who carried out the characterization of the vegetation on part of the Traditional Inca Trail, being apparently uniform along the Kusichaka and Wayllabamba rivers, showing mostly riparian forests and thickets.

Wildlife

On route 1, 21 species of birds distributed in 19 genera were sighted, totalizing 81 individuals in the three years of evaluation. Likewise, 3 species of three different genera of mammals were also sighted, making a total of 10 sightings in the same period (Table 7). It is noted that among the species sighted, two were found in the CITES list of threatened species (CITES, 2015): Lycalopex culpaeus (Appendix I) and Puma concolor (Appendix 2 II). On the other hand, Zonotrichia capensis is the species present and accustomed to the human presence, since it feeds on food debris and due to its opportunistic habits, it is easily observed. In relation to mammals, Mazama americana, P. concolor and L. culpaeus were observed. Most mammals of the Inca trail have been migrating to different places, due to tourism that affects their natural habitat (Aparicio & Huamán, 2009).

On route 2, 18 species of birds in 18 genera were sighted, totalizing 46 individuals during the three years of evaluation. Likewise, 3 species of mammals were sighted, totalizing 3 sightings.

On route 3, 16 genera and 16 species of birds were sighted, making a total of 84 individuals in the three years of evaluation. In addition, one mammal species was sighted during the three years of revaluation.

Table 7: Wildlife registered in the Inca Trail network

	Taxon	N°	Species	Number of sightings								
				Route 1			Route 2			Route 3		
				2008	2009	2010	2008	2009	2010	2008	2009	2010
BIRDS		1	Ampelion rubrocristata	1	0	1	0	0	0	0	0	0
		2	Anairetes parulus	0	1	0	0	0	0	0	0	0
		3	Anisognathus igniventris	1	0	0	0	0	0	0	0	0
		4	Aratinga mitrata	0	0	0	10	0	0	0	0	0
		5	Atlapetes canigenis	1	0	1	0	0	0	0	0	1
		6	Atlapetes tricolor	2	0	2	0	0	0	0	0	0
		7	Boissonneaua matthewsii	0	0	0	1	1	0	0	0	0
		8	Caprimulgus longirostris	2	1	2	0	0	0	0	0	0
		9	Carduelis magellanica	5	0	5	0	0	0	0	0	0
		10	Catamenia inornata	0	1	0	0	0	0	0	0	1
		11	Cinclodes sp	0	0	0	0	0	0	0	1	1
		12	Cloephaga melanophera	0	0	0	0	0	0	1	0	1
		13	Columba fasciata	0	0	0	1	1	0	0	0	0
		14	Diglossa cyanea	0	0	0	0	1	1	0	0	0
		15	Diglossa sp	0	0	0	0	0	0	2	11	5
		16	Elaenia albiceps	0	0	0	1	0	0	0	0	0
		17	Elaenia pallatangae	2	0	2	0	0	0	0	0	0
		18	Falco sparverius	1	3	1	0	0	0	0	1	1
		19	Falcobaenus megalopterus	0	0	0	0	0	0	0	0	1
		20	Frygilus punensis	1	0	1	0	0	0	0	0	0
		21	Frygilus unicolor	0	0	0	0	0	0	2	6	1
		22	Geotrygon frenata	0	0	0	1	0	0	0	0	0
		23	Hemispingus atropileus	1	0	1	0	0	0	0	0	0
		24	Hemispingus superciliaris	1	0	1	0	0	0	0	0	0
		25	Iridosornis jelskii	1	0	1	0	0	0	0	0	0
		26	Lurocalis rufiventris	0	0	0	0	0	1	0	0	0
		27	Merganetta armata	0	0	0	1	0	0	0	0	0
		28	Metalonura sp.	0	1	0	0	0	0	0	0	0
		29	Mionectes striaticollis	0	0	0	1	0	0	0	0	0
		30	Momotus aequatorialis	0	0	0	1	0	0	0	0	0
		31	Mucigula flavinvia	0	0	0	0	0	0	1	1	1
		32	Muscisaxicola maculirostris	1	1	1	0	0	0	0	0	0
		33	Myoborus melanocephalus	1	0	1	0	0	0	0	1	0
		34	Ochothoeca leucophrys	0	1	0	0	0	0	0	0	0
		35	Pachyramphus versicolor	0	0	0	0	1	1	0	0	0
		36	Patagona gigas	0	1	0	0	0	0	0	0	0
		37	Penelope montagnii	0	0	0	1	2	0	0	0	0
		38	Psarocolius angustifrons	0	0	0	0	3	2	0	0	0
		39	Rupicola peruviana	0	0	0	0	1	3	0	0	0
		40	Sayornis nigricans	0	0	0	0	1	0	0	0	0
		41	Serpophaga cinérea	0	0	0	0	1	1	0	0	0

42	Tigrisoma fasciatum	0	0	0	1	0	0	0	0	0
43	Tinamus sp	0	0	0	0	0	0	0	2	1
44	Turdus chiguanco	4	1	4	0	0	0	2	3	3
45	Upucerthia jelskii	0	0	0	0	0	0	1	0	0
46	Vanellus resplendens	0	0	0	0	0	0	0	0	6
47	Vultur gryphus	0	0	0	0	0	0	0	0	1
48	Zenaida auriculata	0	0	0	1	2	3	0	0	0
49	Zonotrichia capensis	8	5	8	0	0	0	8	11	6
	TOTAL INDIVIDUALS	33	16	32	20	14	12	17	37	30
	NUMBER OF SPECIES	16	10	15	11	10	07	07	09	14
MAMMALS	Mazama americana	4	0	4	0	0	0	0	0	0
	Lycalopex culpaeus (Fe)	0	2	0	0	0	0	0	0	1
	Puma concolor (Pr)	1	0	1	0	0	0	0	0	0
	Didelphis marsupialis (Co)	0	0	0	1	0	0	0	0	0
	Nasua nasua	0	0	0	1	0	0	0	0	0
	Odocoileus virginianus	0	0	0	0	1	0	0	0	0
	TOTAL INDIVIDUALS	5	2	5	2	1	0	0	0	1
	NUMBER OF SPECIES	2	1	2	2	1	0	0	0	1

Fe = Feces, Pr = Prints, Co = Corpse.

The MHS has appreciable and recognized wildlife richness (Shoobridge, 2004). The record of animal species is small compared to the species reported for the MHS, being the spectacled bear the most emblematic species, though it has not been observed (directly or indirectly) in any of the evaluation routes. It is noticeable that the incessant movement of tourists on the Inca Trail network causes migration of species that are "little used" to the human presence in their habitats.

The presence of some species of mammals in the Inca Trail network was previously reported by Jarufe (2003), reporting mammals in the Wiñay Wayña sector, such as: Nasua nasua, Didelphis albiventris, Odocoileus virginianus, Mustela frenata and Tremarctos ornatus. In the Group o rodents, the following where reported: Akodon torques, Microryzomys minutus and Myotis nigricans and a vampire, Desmodus rotundus. Likewise, the possible presence of Mazama chunyii, Lontra longicaudis and P. concolor is also reported. Andean fox, L. culpeus and the American lion P. concolor, were not reported by Jarufe (2003). However, these species were reported in the update of the Master Plan of the MHS (SERNANP, 2015).

CONCLUSIONS

Among the specific conclusion, the following can be mentioned:

1. There is a variation in the width and depth of the track in the Inca Trail network in the MHS, but no significant differences were presented.

2. The percentage of remaining solid waste present in the evaluated routes is minimal (0.465% of the total waste generated by travel agencies and disposed by the SERNANP), being of both organic and inorganic nature. The number of objects abandoned on the road causes a negative visual impact on the landscape. The presence of solid waste is basically caused by improper handling of these by the travel and tourism agencies. Likewise, due to the lack of awareness of the supporting personnel who are the main actors for solid waste pollution. On the other hand, the presence of organic waste (droppings) is mainly due to the presence of donkeys and cattle in the first sectors of the three routes of the Inca Trail network.

3. The number of wildlife species recorded (birds and mammals) was low compared to the species reported for MHS. In addition, for this evaluation, species found in any of the appendices of the CITES are reported for this evaluation: L. culpaeus (I), V. gryphus (I) and P. concolor (II). According to the list of endangered wildlife species in Peru, V. gryphus and P. concolor are in danger of extinction.

4. Tourism produces social, cultural and biological impacts, as well as affecting other natural resources such as soil and water. The deterioration natural renewable a non-renewable resources, is one of the most significant direct consequences of tourism. The sites generally preferred for this activity (rivers, lakes and mountains) are fragile ecosystems, whose intensive and unsustainable use can cause irreversible losses. This is because they are subjected to a high flow of visitors and, in the case of MHS, for being a natural and cultural attraction, it is more evident.

5. With regard to negative effects, migration of animal species may be more affected and it should be noted that species considered international conservation categories were recorded. Therefore, the preservation and conservation tasks of these habitats should be intensified, since tourism could represent a constant threat for its permanence in the MHS. On the other hand, tourism in all its forms also generates positive impacts on the economy of the places suitable for this activity, generating jobs and improving in the reception infrastructure for the services related to this activity.

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