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5 **Invisible but Identifiable: p-Chips as a Reliable Marking Method for Amazonian Bats**

6 **Running title:** p-Chip marking in free-ranging Amazonian bats

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16 **Abstract**

17 Marking techniques are essential for studying bat ecology and informing conservation efforts, yet  
18 many existing methods present challenges related to size, tag detectability, and long-term retention.  
19 p-Chips, ultra-miniaturized transponders detectable via red laser light, offer a promising alternative  
20 to traditional banding or passive integrated transponder (PIT) tags. While their use has been  
21 successfully demonstrated in captive bats, their effectiveness in free-ranging populations remains  
22 largely untested. We individually tagged 31 species of bats with p-Chips during a 3-year study in the  
23 Peruvian Amazon. We documented 88 recaptures, with all p-Chips remaining functional over both  
24 short-term (within the same sampling season,  $\leq 40$  days) and long-term (across sampling seasons,  
25 more than 170 to more than 850 days) periods. Notably, no adverse effects such as scarring or tissue  
26 damage were observed. Red light-emitting diode (LED) illumination facilitated rapid visual detection  
27 of tags, reducing handling time. These findings support the use of p-Chips as a viable, detectable,  
28 minimally invasive, and cost-effective alternative to PIT tags, particularly for small-bodied species.  
29 We recommend further research to optimize p-Chip technology for broader application in wildlife  
30 tracking and conservation.

31 **Keywords:** Chiroptera, forearm, long-term mark, mark-recapture, technology, wild bats

## 32 Introduction

33 Individual identification of bats is critical for applied conservation research programs addressing  
34 population dynamics, aging, health, and mortality (e.g., van Harten et al., 2022; Humphrey and Oli,  
35 2015; Jin et al., 2012; O’Shea et al., 2010; O’Shea et al., 2004; Cheng and Lee, 2002). Researchers  
36 have employed a variety of methods to mark bats individually for long-term monitoring (Kunz and  
37 Weise, 2009). Nevertheless, choosing the most effective marking technique remains a challenge, as  
38 available techniques vary in terms of cost, durability, practicality, and their impacts on animal health  
39 and behavior (Loeb et al., 2025; Reynolds et al., 2025; Lobato-Bailón et al., 2023; Markotter et al.  
40 2023, Mellado et al., 2022; Kunz and Weise, 2009). Effectiveness may also depend on the species,  
41 necessitating the use of multiple complementary approaches (Kunz and Weise, 2009; Bonaccorso et  
42 al., 1976).

43 Historically, forearm bands have been widely used due to their relatively low cost and ease of  
44 application (Kunz and Weise, 2009). However, concerns over lethal and sublethal injuries, and  
45 potential interference with foraging activities in a range of species (Lobato-Bailón et al., 2023), have  
46 prompted researchers to explore alternatives (Loeb et al., 2025; Markotter et al., 2023; Kirkpatrick et  
47 al., 2019; Kunz and Weise, 2009; Sherwin et al., 2002; Barnard, 1989).

48 Passive integrated transponder (PIT) tags, a type of radio-frequency identification (RFID) marker,  
49 have frequently been employed to permanently mark bats over the last few decades (Fontaine et al.,  
50 2024; Escobar et al., 2022; Locatelli et al., 2019; Britzke et al., 2014; Rigby et al., 2012; Ellison et  
51 al., 2007; Neubaum et al., 2005; Kerth and Reckardt, 2003; Schooley et al., 1993; Barnard, 1989).  
52 These subcutaneous tags encode a unique identification number that is readable by RFID readers,  
53 which can even be adapted to automatically detect bats at roost entrances (Rivera-Villanueva et al.,  
54 2024; Adams and Ammerman, 2015; Britzke et al., 2014). Although PIT tags are commonly used and  
55 believed to have no adverse effects on the body mass, body condition, and/or reproductive success of  
56 bats (Waag et al., 2025; van Harten et al., 2019; Locatelli et al., 2019; Rigby et al., 2012; Neubaum  
57 et al., 2005), they have some limitations. Their application typically requires a large needle (12-  
58 gauge), which may be invasive for smaller species (Sehult et al., 2024). Tags are not externally  
59 visible; therefore, the use of a hand-held ID reader is required. Nevertheless, they can migrate or even  
60 be occasionally expelled from the body, in which case it may lead to detection difficulties or data loss  
61 (van Harten et al., 2021; Rigby et al., 2012; Kunz and Weise, 2009; Barnard, 1989). Finally, they are  
62 cost-prohibitive for large-scale studies (USD 5–10; Sehult et al., 2024), but these prices vary  
63 depending on the vendor and the quantity purchased. Generally, PIT tags are preferable to forearm  
64 bands due to their higher retention rates (van Harten et al., 2021; Ellison et al., 2007); however,

65 concerns over cost, detectability, potential safety issues for very small bats (forearm length < 30 mm),  
66 and tag loss in some studies (e.g., Rigby et al., 2012) warrant investigation into alternative  
67 technologies.

68 p-Chips (p-Chip Corp., Chicago, Illinois) are ultra-miniaturized semiconductor transponders (500 ×  
69 500 μm) that emit a unique ID when activated by red laser light (PharmaSeq, 2012). Although they  
70 were designed for a wide range of applications, including labeling, tracking, and authenticating items,  
71 their initial use in animals was the permanent identification of laboratory mice (Gruda et al., 2010;  
72 PharmaSeq, 2012).

73 Because the laser must be close to the tag (ca. 1 cm) to achieve a successful read, it is beneficial to  
74 inject the tag in an area with thin, translucent, and almost hairless skin. p-Chip tags are injected  
75 subcutaneously via a 21-gauge needle, which is less invasive than the 12-gauge needles commonly  
76 used for PIT tag injection. This makes p-Chips a promising alternative for marking bats, especially  
77 smaller species (Ngamprasertwong et al., 2022; Gruda et al., 2010). p-Chips (1–2 USD per unit) can  
78 also be five- to ten-fold less expensive than PIT tags (Seheult et al., 2024). However, it should be  
79 recognized that the hand-held reader is expensive (up to USD 3,000) because it is only available  
80 directly from the company; unlike PIT tags, there are no generic alternatives. p-Chips (p-Chip Corp.)  
81 were available in either preloaded or loose formats. In the latter case, they can be manually loaded  
82 into injectors, which can be sterilized between uses or discarded. Currently, PharmaSeq (the company  
83 that used to sell preloaded injectors) is no longer engaged in commercial sales of p-Chips or preloaded  
84 injectors. Researchers interested in using p-Chips may contact p-Chip Corp. directly to purchase them  
85 (p-Chip Corp., personal communication) and adapt other needles for use in injection (see Methods).

86 p-Chips have been successfully used for marking and identification in animals of various sizes,  
87 including fish (Spooner and Spurgeon, 2024; Moore and Brewer, 2021; Faggion et al., 2020), rodents  
88 (Clein et al., 2024; Warren et al., 2021; San Diego Zoo Wildlife Alliance, 2016), crayfish (Huber et  
89 al., 2023), salamanders (Moore et al., 2024), bees (Hamilton et al., 2019; Tenczar et al., 2014), ants  
90 (Robinson et al., 2014; Robinson et al., 2009), and even ectoparasites (Folk et al., 2024). Although  
91 most evidence comes from captive conditions, p-Chips have been shown to be effective identification  
92 markers for wild fish (Spooner and Spurgeon, 2024; Moore, 2020), demonstrating no significant  
93 adverse effects and a tag retention rate of up to 94% after more than a year, even in underwater  
94 conditions. In wild animals, p-Chips are expected to function indefinitely due to their polymer  
95 coating, which resists harsh conditions such as high temperatures, freezing–thawing cycles, and even  
96 exposure to chemicals (PharmaSeq, 2012). Therefore, p-Chips are a suitable, considerably smaller  
97 alternative to PIT tags. Although p-Chips still require the recapture of marked individuals, their

98 reduced size represents a promising avenue for innovation in small-sized species for which traditional  
99 marking techniques are impractical or invasive.

100 Seheult et al. (2024) tested p-Chips in 30 captive *Eptesicus fuscus* (forearm length: 40–48 mm),  
101 inserting them in the skin of the wings and tibia. They found that the tags remained functional for  
102 over a year (464 days after tagging) while requiring minimal handling due to rapid detection with the  
103 scanner. However, they also noted that visibility decreased over time, which may complicate  
104 recapture efforts. This issue could pose a significant challenge in free-ranging bats, where uncertainty  
105 about prior tagging might lead to excessive handling in an effort to locate a potentially nonexistent  
106 tag.

107 Given these challenges, further testing in more species and under non-captive conditions was  
108 recommended. The purpose of this study was to evaluate p-Chip tag efficacy in a free-ranging  
109 population of Amazonian bats by assessing their application, detectability, and retention across  
110 species.

## 111 **Methodology**

112 This study was conducted at the Estación Biológica Los Amigos (EBLA), located in the southeastern  
113 Peruvian Amazon, at the confluence of the Los Amigos and Madre de Dios Rivers (12°30'–12°36'S,  
114 70°02'–70°09'W). The region primarily consists of high and low terra firme forests, flooded palm  
115 forests, and meandering river floodplain forests (MINAM, 2015). According to the *Servicio Nacional*  
116 *de Meteorología e Hidrología del Perú* (SENAMHI), in Puerto Maldonado (~50 km away, the nearest  
117 site), temperature ranges from 16.6°C to 32.2°C, and monthly precipitation varies from 58 to 299  
118 mm. At this site, an annual mark-recapture program for medium and large mammals has been ongoing  
119 since 2018, during which we were able to test this method for the individual identification of bats.  
120 Although sampling of bats has taken place since 2018, marking efforts began only at the end of our  
121 2023 field season (end of July–beginning of August).

122 From 2023 to 2025, we captured bats using 6 × 3 m and 12 × 3 m mist nets at accessible sites along  
123 the trail system at the field station (Watsa et al., 2023; Figure 1). Bats were identified taxonomically  
124 using the dichotomous keys from López-Baucells et al. (2016) and Díaz et al. (2021), and aged based  
125 on epiphyseal ossification (Brunet-Rossinni and Wilkinson, 2009). To individually mark bats, p-  
126 Chips (USD 0.67 each in 2023; PharmaSeq) were subcutaneously implanted into the right mid-  
127 forearm region of each animal, primarily using preloaded 21-gauge needles (Figure 2, Video S1). To  
128 replicate the preloaded injectors developed by p-Chip Corp. (p-Chip Corp., personal communication),  
129 in 2025 we manually flattened 40 conventional 21-gauge needles using a press (Gruda et al., 2010),

130 then loaded them with loose p-Chips under sterile, controlled conditions. These needles were used to  
131 insert the p-Chips into bats and performed comparably to the preloaded needles. The forearm was  
132 selected as the implantation site to accommodate the wide range of body sizes included in this study,  
133 particularly smaller-bodied species, in which implantation in the metacarpals may be anatomically  
134 unfeasible or difficult due to needle gauge relative to bone width. We ensured that each p-Chip was  
135 inserted into a disinfected injection site while being careful that the chip remained right-side up to  
136 maintain detectability.

137 Individual tag numbers were checked using the handheld reader (model WA-6000) connected to a  
138 Windows 10 laptop or tablet via a USB connection. We purchased our reader from PharmaSeq for  
139 USD 3,000 in 2023, whereas Seheult et al. (2024) reported a cost of USD 2,000 for the model WA-  
140 4000. During preliminary tests, we identified instances where some p-Chips were unreadable or  
141 preloaded in a flipped orientation. For this reason, we checked them before injection by slightly  
142 exposing the p-Chip using the needle plunger to verify its readability and orientation before  
143 implanting it. Additionally, the ongoing bat research program involved collecting fur for toxicology  
144 analyses and wing punches for DNA barcoding, both serving as short-term external marks that helped  
145 confirm recaptures when p-Chip detectability was initially uncertain. Once red LED-assisted  
146 visualization reliably revealed the presence of tags under the skin, these auxiliary short-term marks  
147 were no longer needed for this purpose. No standardized measures of scanning time or handling time  
148 were recorded.

149 We defined eight sampling sites where we have conducted bat sampling since we began marking bats  
150 with p-Chips. In 2024, we ran out of p-Chips for sites 1, 5, and 7; however, we report our full sampling  
151 schedule (Supplementary Table S2) because recaptures were recorded at sites 1 and 7. Mist-net  
152 locations were georeferenced to measure distances between recapture events. We assessed tag  
153 functionality within and across years by recording the distance and time between recapture encounters  
154 of individuals.

155 Mist-netting effort was not standardized across sites or nights. Nets were installed in single-high  
156 configurations, but the number of nets deployed per night varied with logistical and environmental  
157 constraints and with the objectives prioritized by the ongoing research program since 2018. As a  
158 result, our mark–recapture assessment was opportunistic, and we therefore do not quantify recapture  
159 rates or success. Our observations of recapture events are reported to document p-Chip visual  
160 detection, readability, and retention under typical field conditions.

161 This study was conducted with permit RDG-000116-2021-DGGSPFFS (*Servicio Nacional Forestal*  
162 *y de Fauna Silvestre*; SERFOR), following the guidelines of the American Society of Mammalogists  
163 (Sikes et al., 2016) and under IACUC approval from Washington University in St. Louis and the San  
164 Diego Zoo Wildlife Alliance. The full handling protocol is provided in Watsa et al. (2023).

## 165 **Results**

166 Bats were sampled and tagged from 2023 to 2025 (details in Supplementary Table S2). In 2023, p-  
167 Chips were implanted in 24 bats across eight species; in 2024, in 97 bats across 19 species; and in  
168 2025, in 179 bats across 27 species (Table 1). In total, we implanted tags in 31 species across three  
169 families (Phyllostomidae, Emballonuridae, and Vespertilionidae), spanning a wide range of body  
170 sizes from small bats (forearm length < 36 mm) to very large bats (forearm length > 75 mm). The  
171 smallest tagged individual had a forearm length of 29.7 mm (*Mesophylla macconnelli*), whereas the  
172 largest individual was *Vampyrum spectrum* with a forearm length of 108.1 mm. p-Chip visual  
173 detection and reading were successful across this size range; however, standardized metrics were not  
174 collected (e.g., detection/reading time), precluding formal comparisons of efficiency among size  
175 classes.

176 Over the entire study period, we recaptured 57 individual bats (12 species) across 88 recapture events,  
177 because some individuals were recaptured more than once (Table 2; Supplementary Table S2). The  
178 smallest recaptured individual had a forearm length of 31 mm (*Hsunycteris thomasi*), and the largest  
179 had a forearm length of 87.5 mm (*Phyllostomus hastatus*). All recaptured individuals that were  
180 expected to carry a functional p-Chip, based on complementary marks (shaved hair or wing biopsy  
181 marks), retained the tag, which remained fully functional.

182 In all recaptured individuals, the injection site was not detectable, with no visible scarring,  
183 inflammation, or other apparent adverse effects, including in individuals recaptured more than one  
184 year after tagging. During the first sampling sessions, we sometimes had difficulty visually locating  
185 the p-Chip immediately after injection and during some recapture events. Visual detectability of the  
186 p-Chip varied among species. In bats with dark or thick skin (e.g., *Phyllostomus* spp. and *Vampyrum*  
187 *spectrum*), the tag was not externally visible under ambient light and could be confused with natural  
188 pigmentation patterns, skin markings, or minor wounds. We later found that placing a red LED  
189 backlight beneath the wing caused the p-Chip to appear clearly as a black, opaque square, even in  
190 dark-skinned species (Figure 2; Video S2). This technique consistently enabled rapid visual detection  
191 and tag reading across all species, regardless of size or skin characteristics. Scanning time was  
192 reduced to a few seconds per individual (< 15 s; approximate upper limit based on rough field

193 estimates), and tags were typically read on the first attempt with the handheld reader. After  
194 implementing this technique and as the handling team gained experience, all implanted p-Chips were  
195 successfully detected and scanned.

196 Notably, 16 individuals across six species were recaptured after more than 170 days after the marking  
197 date (across sampling seasons), including the notable recapture event of a female *Carollia brevicauda*  
198 captured more than two years after the marking date (859 days) (Table 2). The remaining individuals  
199 were recaptured within short periods (0–40 days) after the marking date (Table 2; Supplementary  
200 Table S2). Four individuals (3 species) were recaptured at distances over 1 km from previous capture  
201 locations, while all other individuals were recaptured between 0 and 500 m from previous capture  
202 locations (Table 2; Supplementary Table S2).

## 203 **Discussion**

204 Previously, Seheult et al. (2024) tested p-Chips in captive *E. fuscus*, while Ngamprasertwong et al.  
205 (2022) used them to study roost fidelity in *Craseonycteris thonglongyai*, the smallest bat in the world.  
206 Our results provide the first evidence of their use in free-ranging bats within a highly diverse  
207 Amazonian high-terrace forest. p-Chips were inserted and successfully read in the forearm of 31 bat  
208 species. The short-term functionality of the tags (within the same sampling season, up to 40 days)  
209 was confirmed in 41 individuals across nine species, while long-term functionality (across sampling  
210 seasons, > 170 days) was confirmed in 16 individuals across six species (Table 1; Supplementary  
211 Table S2).

212 We demonstrate that inserting p-Chips in the forearm is feasible and effective. Although forearm  
213 implantation may reduce visual detectability in large, dark-skinned species, the use of red LED  
214 backlighting overcomes previously reported limitations in visual tag localization and enables reliable  
215 tag detection across all species. This approach expands the applicability of p-Chips across  
216 morphologically diverse bat taxa. After implementing pre-injection verification, we did not observe  
217 any flipped p-Chips in preloaded syringes, except possibly during the initial sessions before  
218 verification was applied. However, we do not rule out the possibility that tags may flip over time, as  
219 noted by Seheult et al. (2024). Although we did not quantitatively assess p-Chip efficacy by species,  
220 our observations suggest that p-Chip functionality is consistent across the species tested using the  
221 methods we deployed. As with any marking technique, practice is required to achieve consistently  
222 successful application. Although the fine-gauge needle used for p-Chip marking allows all species to  
223 be tagged with minimal difficulty, handling and tagging very small species may be slightly more

224 challenging. Nevertheless, we expect that training in this technique would be straightforward for new  
225 users when following our protocol.

226 Importantly, we did not detect any visible tissue damage or other adverse effects at the implantation  
227 site in any recaptured individuals, including those recaptured more than one year after tagging.  
228 Although our sampling design does not allow precise quantitative estimates of tag retention or loss in  
229 free-ranging bats, these observations suggest that the implantation protocol used here (Watsa et al.,  
230 2023) is unlikely to cause detectable morbidity or acute adverse effects associated with p-Chip  
231 application. Observations from Scheult et al. (2024) in captive bats further support that mortality or  
232 other adverse effects due to p-Chip insertion are highly improbable. Future work could assess tag loss  
233 rates in wild bats. Although tag loss appears low in captive bats, estimating loss in free-ranging  
234 individuals is challenging; targeted sampling at roosts with high site fidelity may be well suited for  
235 this purpose. In addition, consistent with that study in captive bats, we recommend that future  
236 evaluations also include other marking methods (e.g., bands, PIT tags) to allow quantitative  
237 comparisons of efficiency. Finally, where possible, we recommend assessing whether p-Chips may  
238 alter the behavior and physiology of wild bats.

239 Although the number of recaptured bats may appear low, recapture rates in the Amazon are commonly  
240 low (e.g., Tavares et al., 2017; Ramos et al., 2010; Sampaio et al., 2003), including at EBLA (Bravo  
241 et al., 2008). Comprehensive sampling in the Amazon is logistically challenging because much of the  
242 habitat within a given site is inaccessible. Even in areas with established trails, such as EBLA, it is  
243 difficult to sample large areas simultaneously. Recapturing free-ranging bats is further complicated  
244 by the potential for long-distance movements; for example, *Artibeus lituratus* can travel up to 113  
245 km (Arnone et al., 2016), and movement data for most species are scarce. Given these constraints,  
246 our recapture records across time and space support the effectiveness of p-Chips as a marking method.  
247 Several individuals were recaptured more than one year after marking (including one more than two  
248 years after marking), sometimes at the same site, whereas a few were recaptured at more distant sites  
249 within relatively short time intervals. Recaptures at the same site after more than a year may indicate  
250 roost or foraging-area fidelity, although our sampling design does not allow stronger inference.  
251 Together, these results highlight the potential value of p-Chips for large-scale mark-recapture  
252 programs across Amazonian bat communities, an approach that has likely been uncommon because  
253 of cost and feasibility constraints for some species. Future work could implement a systematic, long-  
254 term sampling design that periodically surveys specific areas. Priority sites could include spatially  
255 clustered, high-resource locations that attract bats from long distances (e.g., mammal clay licks) and  
256 major roost sites.

257 Standardized protocols are essential to advance research using this technique. In particular, consistent  
258 placement of p-Chips is critical to ensure reliable localization during recapture events, especially  
259 given the absence of visible external marks after healing. This standardization is also crucial for  
260 eventually applying p-Chips across broader geographic contexts and among multiple research teams.  
261 In addition, although preloaded injectors are not currently available commercially, the process of  
262 modifying conventional needles and manually loading p-Chips is very straightforward. To our  
263 knowledge, there is no commercially available alternative with the same combination of extreme  
264 miniaturization and light-triggered close-range detection, although other small implantable RFID  
265 systems exist.

266 Our study contributes information on the long-term retention of p-Chips in free-ranging bats, the  
267 importance of proper insertion techniques, and the benefits of pre-injection confirmation and red LED  
268 backlighting to improve readability. These results suggest that p-Chips are an effective and minimally  
269 invasive method for longitudinal research on wild bats, offering a viable alternative to PIT tags,  
270 particularly for smaller species.

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434

435 **Table 1.** Number of individuals per species tagged with p-Chips during the study period at the  
 436 Estación Biológica Los Amigos (Peru). Size categories were arbitrarily defined based on the average  
 437 forearm length (FA) of the captured individuals in this study.

Size category	Species	2023	2024	2025
Small (FA: < 36 mm; n = 69)	<i>Carollia benkeithi</i>	3	8	12
	<i>Glossophaga soricina</i>			5
	<i>Hsunycteris thomasi</i>			1
	<i>Mesophylla macconnelli</i>		1	3
	<i>Micronycteris microtis</i>			1
	<i>Micronycteris minuta</i>		1	3
	<i>Myotis nigricans</i>			1
	<i>Myotis riparius</i>		3	8
	<i>Rhinophylla pumilio</i>	1	2	15
	<i>Thyroptera tricolor</i>			1
	Medium (FA: 36 – 55 mm; n = 127)	<i>Carollia brevicauda</i>	5	23
<i>Carollia perspicillata</i>		2	17	34
<i>Chiroderma trinitatum</i>				1
<i>Dermanura anderseni</i>			1	
<i>Dermanura gnoma</i>			1	2
<i>Gardnerycteris crenulata</i>			1	5
<i>Micronycteris hirsuta</i>			1	
<i>Saccopteryx bilineata</i>			1	
<i>Sturnira tildae</i>				2
<i>Trinycteris nicefori</i>				4
Large (FA: 55 – 75 mm; n = 83)		<i>Artibeus lituratus</i>	1	
	<i>Artibeus obscurus</i>	4	12	5
	<i>Artibeus planirostris</i>	2		11
	<i>Desmodus rotundus</i>			1
	<i>Lophostoma silvicola</i>		8	8
	<i>Phyllostomus elongatus</i>		5	14
	<i>Platyrrhinus infuscus</i>			1
	<i>Tonatia maresi</i>		3	3
	<i>Trachops cirrhosus</i>		1	2
Very large (FA: > 75 mm; n = 21)	<i>Phyllostomus hastatus</i>	6	7	7
	<i>Vampyrum spectrum</i>		1	

439 **Table 2.** Bats marked with p-Chips and recaptured at Estación Biológica Los Amigos, Peru. Only the  
440 individuals with the longest intervals and the greatest distances between initial capture/markings and  
441 subsequent recapture locations are shown. Each row corresponds to a unique individual. Full detailed  
442 results are available in Supplementary Table S2. For each individual, the table lists the marking date,  
443 the number of recapture events, the maximum number of days from marking to the last recapture, and  
444 the maximum distance between the marking site and recapture events. “Recapture site” indicates the  
445 site of the farthest recapture. Abbreviations: a, adult; j, juvenile; p, pregnant. \*Captured as juvenile  
446 and recaptured as adult; †captured as adult non-pregnant and recaptured as pregnant; ‡captured and  
447 recaptured as pregnant.

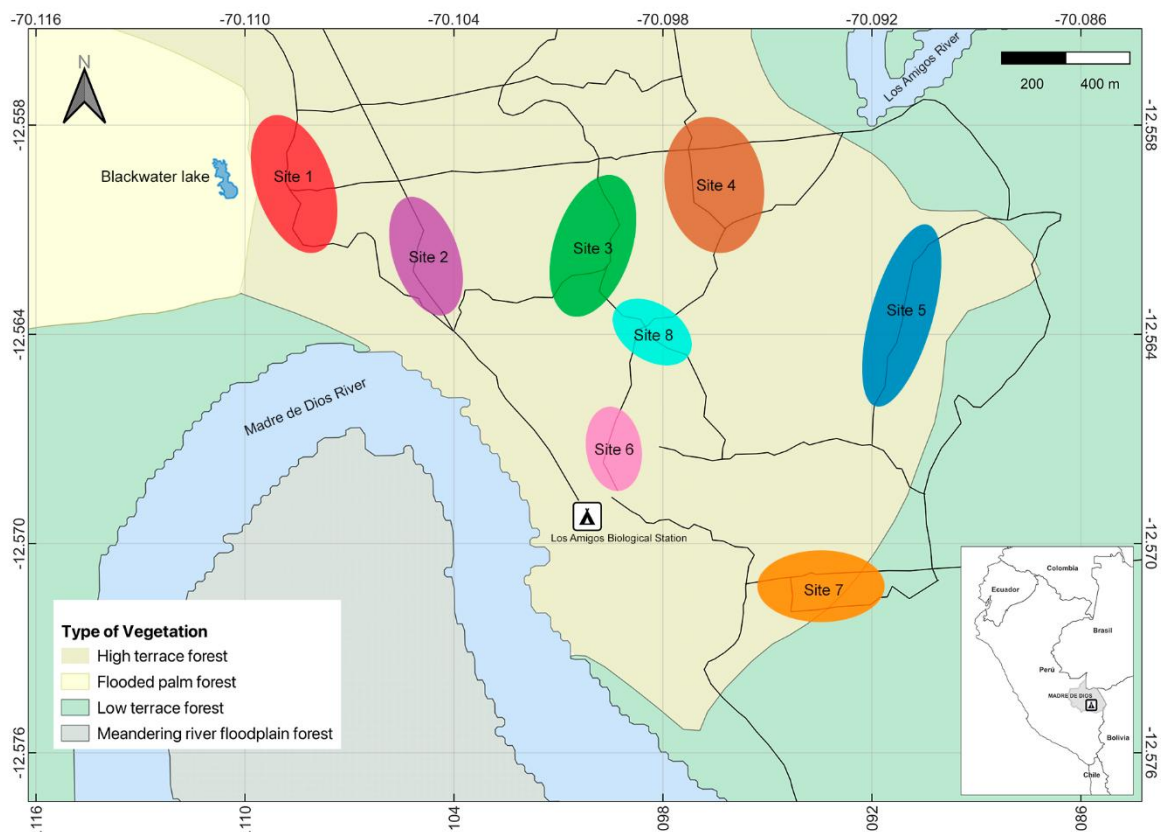
Bat individual	Date marking	Max. days to recapture	Max. distance traveled	Recapture times	Marking site	Recapture site
<i>Carollia brevicauda</i> ♀j,a*	21/07/2023	344	1014	1	3	1
<i>Artibeus obscurus</i> ♂a	21/07/2023	334	234	1	3	3
<i>Carollia benkeithi</i> ♀a	26/07/2023	334	22	1	2	2
<i>Carollia brevicauda</i> ♀a	03/08/2023	859	192	1	2	2
<i>Phyllostomus elongatus</i> ♂a	11/06/2024	32	194	1	4	4
<i>Carollia brevicauda</i> ♂a	13/06/2024	30	319	1	4	4
<i>Tonatia maresi</i> ♂a	14/06/2024	366	471	1	4	8
<i>Carollia brevicauda</i> ♀a,p†	17/06/2024	345	90	3	4	4
<i>Carollia brevicauda</i> ♀a	18/06/2024	345	131	1	4	4
<i>Artibeus obscurus</i> ♂a	20/06/2024	17	1138	1	3	7
<i>Carollia brevicauda</i> ♂a	20/06/2024	355	160	2	3	3
<i>Carollia brevicauda</i> ♀a	20/06/2024	17	1190	2	3	7
<i>Carollia brevicauda</i> ♀a	20/06/2024	360	217	3	3	8
<i>Lophostoma silvicola</i> ♂a	20/06/2024	374	303	1	3	8
<i>Lophostoma silvicola</i> ♀a	24/06/2024	350	286	2	3	3
<i>Carollia benkeithi</i> ♀a	25/06/2024	343	74	3	2	2
<i>Carollia benkeithi</i> ♂a	25/06/2024	343	160	3	2	2
<i>Carollia perspicillata</i> ♀a	25/06/2024	3	435	1	2	1
<i>Carollia brevicauda</i> ♂a	08/07/2024	542	468	2	6	8
<i>Carollia perspicillata</i> ♀a,p	29/05/2025	17	458	1	4	8
<i>Carollia perspicillata</i> ♂a	30/05/2025	18	443	2	4	8
<i>Carollia perspicillata</i> ♂a	30/05/2025	33	468	1	4	3
<i>Carollia perspicillata</i> ♀a	30/05/2025	20	497	2	4	8
<i>Carollia brevicauda</i> ♂a	04/06/2025	28	365	1	2	3
<i>Carollia brevicauda</i> ♀a,p‡	10/06/2025	176	421	8	3	8
<i>Carollia brevicauda</i> ♂a	11/06/2025	27	327	2	3	8
<i>Carollia benkeithi</i> ♀a	13/06/2025	25	360	4	3	8
<i>Phyllostomus elongatus</i> ♀a	16/06/2025	32	1102	1	8	1
<i>Phyllostomus elongatus</i> ♀a	19/06/2025	171	287	1	8	3

448 **Figure 1.** Bat capture sites at the Estación Biológica Los Amigos (Peru). The vegetation types follow  
449 MINAM (2015). Details on the days evaluated at each site are in Supplementary Table S2.

450 **Figure 2.** Visualization of p-Chips implanted in the mid-forearm of free-ranging bats at the Estación  
451 Biológica Los Amigos (Peru). Each column corresponds to a different individual, with the top and  
452 bottom images showing the same individual under natural light and red LED backlighting,  
453 respectively. Arrows indicate the location of the p-Chip when visually detectable. Scale bars = 5 mm.  
454 *Carollia brevicauda* (A, B); *Carollia benkeithi* (C, D); *Lophostoma silvicola* (E, F); *Artibeus*  
455 *obscurus* (G, H); *Phyllostomus hastatus* (I, J). A video demonstration of p-Chip visualization and  
456 reading is available in Video S1.

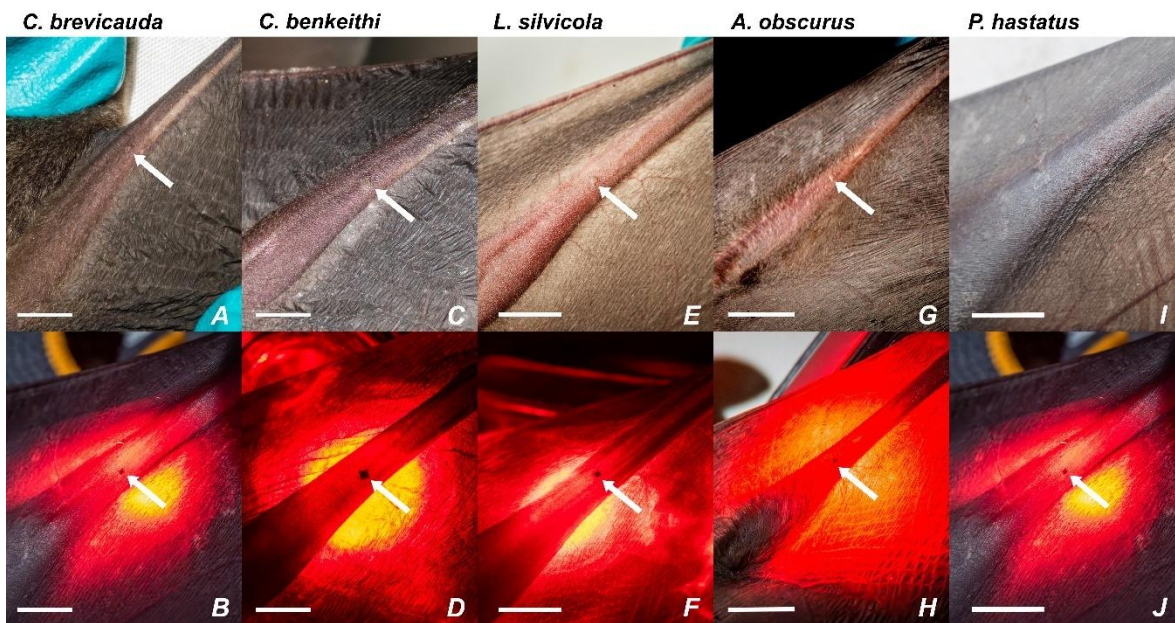
457

458 **Figure 1**



459 **Figure 2**

460



461 **Video S1.** Demonstration of p-chip placement and reading in a free-ranging *Phyllostomus elongatus*  
462 at the Estación Biológica Los Amigos (Peru). The images are just previews of the video. During the  
463 review process, it will be available at this link:  
464 <https://drive.google.com/file/d/1pIHgsqXfBpOb7tb8dfRu0pJMNg88YSR5/view?usp=sharing>  
465

