Western Riverside County MSHCP
Biological Monitoring Program
Los Angeles Pocket Mouse 2022 Occupancy Protocol

INTRODUCTION

Los Angeles pocket mouse (*Perognathus longimembris brevinasus*; LAPM) is a California species of special concern that historically ranged from the San Fernando Valley eastward to the city of San Bernardino and southeast to the Aguanga area of Riverside County (Williams et al. 1993). The species typically occurs on open landscapes associated with alluvial, aeolian, or well-drained uplands deposits of sandy soil, and is believed to be in decline due to habitat loss affiliated with agricultural and urban development (Jameson and Peeters 1988; Williams et al. 1993; Dudek & Associates 2003). The current distribution of Los Angeles pocket mouse across the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) Area is not well understood, partly due to seasonal cycles of activity making this species difficult to detect.

Los Angeles pocket mouse spends much of its life underground, with ephemeral bouts of surface activity offset by intervals of subterranean aestivation and torpor (French 1976; 1977). Timing and duration of activity cycles can vary across seasons, and appear to be a function of soil temperature, food availability, and ambient air temperature (French 1976; 1977). Detectability of Los Angeles pocket mouse is therefore dependent on conditions suitable for surface activity when the species is available for trapping, and population estimates should account for variation in detectability across and within seasons.

The MSHCP identifies four species objectives for LAPM, three of which apply to how and where we will survey in 2020. First, at least 14,000 acres of suitable habitat will be conserved with at least 2000 acres within each of seven probable Core Areas; 1) San Jacinto Wildlife Area – Lake Perris State Park, 2) The Badlands, 3) San Jacinto River – Bautista Creek, 4) Anza Valley, 5) Southwest Riverside County Multi Species Reserve (MSR), 6) Potrero Valley (Potrero), and 7) Temecula Creek. Second, conserve at least 10,000 acres outside of probable Core Areas; Wilson Creek, San Gorgonio Wash, Warm Springs Creek, San Timoteo Creek and Vail Lake. Finally, each probable Core Area must support a stable or increasing population with at least 30% of suitable habitat occupied, as measured over any 8-consecutive year period (Dudek & Associates 2003).

In 2010, the Biological Monitoring Program began a multi-year effort to address population distribution and trend for LAPM. Using a repeat visit design with random grid distribution, we targeted modeled habitat in each Core Area with 5 x 5 (28 m x 28 m) trapping grids following a Percent Area Occupancy (PAO) design (MacKenzie et al. 2006). We captured LAPM in 4 of 7 Core Areas. We resurveyed those same occupied Core Areas for an additional 2 years in an effort to determine population trend. All 4 Core Areas remained occupied by LAPM and we saw occupancy estimates and detection probability remained somewhat constant throughout the multi-year project. In 2020, we trapped these same 4 occupied Core Areas and conducted habitat surveys to determine what habitat covariates may be important in explaining LAPM presence. We found the all four Core Areas occupied and a two sample t-test showed percent cover of both *Lepidospartum squamatum* and bare ground was higher at LAPM occupied grids. We also performed a logistic regression and found *Lepidospartum squamatum* was

positively related to LAPM presence while *Eriogonum* spp was negatively related to LAPM occupancy. In 2021, we resampled the grids trapped in 2020 and detected LAPM at two of the four Core Areas; San Jacinto Wildlife Area – Lake Perris State Park and San Jacinto River – Bautista Creek. Our goals and objectives for surveying Los Angeles pocket mouse in 2022 are specifically listed below.

Goals and Objectives

1. Document Los Angeles Pocket Mouse occupancy in Core Areas where occupancy was previously recorded through trapping efforts undertaken by the Biological Monitoring Program.
    a. Sample LAPM populations with 5 x 5 (28 m x 28 m, 25 trap) trapping grids.
2. Report population trend in occupied Core Areas.
    a. Estimate occupancy with a closed-capture model using Program MARK.
    b. Compare occupancy estimates and detection probability for all years sampled.

METHODS

Survey Design

We will survey the four probable Core Areas listed where Los Angeles pocket mouse have been detected in recent survey efforts (Figure 1). We will re-survey grids that were distributed in 2010, and modified in 2020, using the methods described in Biological Monitoring Program (2011; 2021) and summarized here: we stratified Core Areas by suitable habitat based on soil and vegetation characteristics known to be associated with Los Angeles pocket mouse and closely related Pacific pocket mouse (*P. l. pacificus*). We specifically targeted sandy to loamy-sand soils, as well as sandy loam soils. These soil types are found in alluvium and well-drained upland areas (Bornyasz 2003). We included grassland, coastal sage scrub, chaparral, desert scrub, Riversidean alluvial fan scrub, playas and vernal pools, as well as water (e.g., alluvial stream beds) vegetation types (Dudek & Associates 2003).

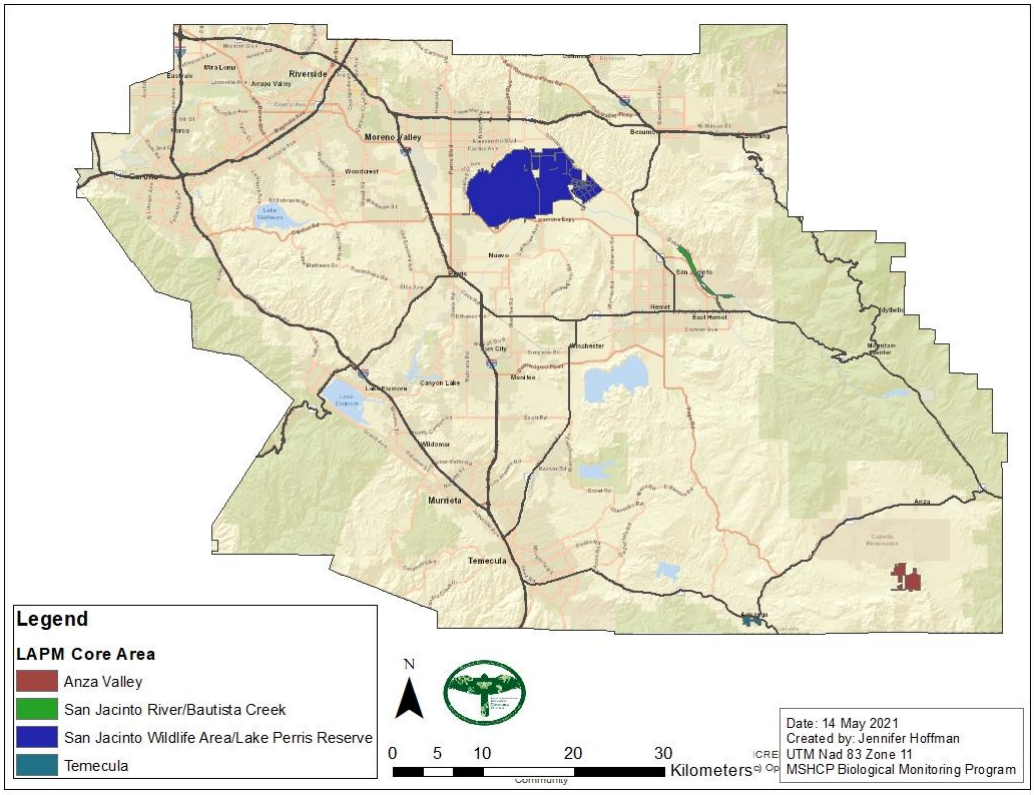

Figure 1. Los Angeles pocket mouse Core Areas to survey in 2022.

We modeled suitable habitat using Arc GIS Desktop v 10.7 software (ESRI 2006) to select the above described attributes from GIS-based soil (Soil Survey Staff et al. 2006) and vegetation (CDFG 2005) maps. We then defined an area of inference based on accessible habitat that is no further than 600 m from drivable roads, and does not occur on excessive slope (i.e., > 15 degrees) as described by a digital elevation model (USGS 2006).

Timing of Los Angeles pocket mouse activity, availability of field crew, and effect of moon phase on animal detectability will dictate that we survey in 2022 from late May to September, across 8, 4-night efforts, 6 to 13 grids sampled per effort. We placed a 20-m negative buffer on the inference area to control for grids falling beyond modeled habitat, and distributed points within this buffer using the Hawth's Tool extension for Arc GIS. Sample independence is maintained with a minimum spacing of 80 m between grid-center points (Shier 2009). We centered a 28 m x 28 m trapping grid on each random point, with 7-m spacing between traps for a total of 25 traps per grid (i.e., 5 x 5; Figure 2). We plan to survey the same trapping grids surveyed in 2020 (Biological Monitoring Program 2021).

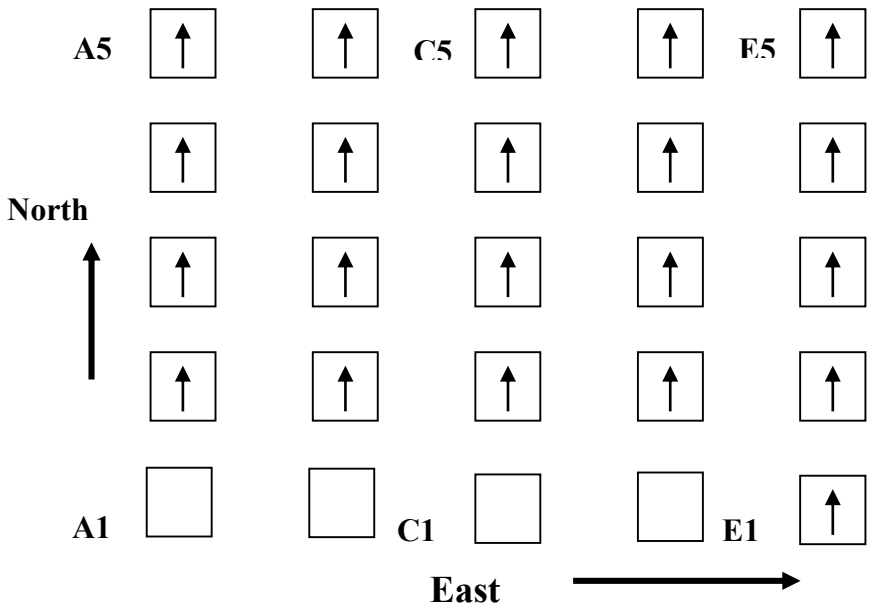

Figure 2. Grid design (5 × 5) for trapping small mammals. Boxes represent individual traps and arrows indicate direction of open doors. Traps are labeled alphabetically, increasing eastward; and numerically, increasing northward.

We will survey each grid over a single 4-night effort (Monday to Thursday) following an occupancy design framework (Mackenzie et al. 2006). Lunar brightness has been shown to decrease small-mammal activity (Daly et al. 1992). Therefore, to the best of our abilities, we will schedule two weeks of trapping efforts each month to coincide with new-moon cycle. Timing of survey efforts beyond 2022 will be based on availability of field staff. Though, we plan to include at least 1 additional year for collecting trapping and habitat data in Core Areas where LAPM have not been detected since 2010. We will follow the same survey design and sample the same grid points described above for future efforts.

Field Methods

We will sample grids using 12″ x 3″ x 3.5″ Sherman live traps baited with 1 tablespoon of sterilized large-white Proso millet and modified with paper clips to restrict trap doors from closing completely and potentially damaging animal tails. We will place a single trap ≤1 m from each trap station (n = 25 per grid), and mark their position with an alpha-numerically labeled pin flag (e.g., A1 to E5). If pin flag is obscured by vegetation, pink flagging will be tied above the pin flag. We will mark the southwest corner of each grid with a wooden stake labeled with grid ID and flagged with reflective tape. New in 2022, we will take a digital photo of each trapping grid upon set up. Photos will be taken from trap station C1, facing North, with the camera 1.5 m above the ground. A pin flag for trap station C3 marking the grids' center should appear in the photograph. See Data Management section below for instructions on data photo entry and storage. We will open and bait traps 1 to 3 hours before sunset the evening prior to trapping. Traps will be checked twice each night in accordance with U.S. Fish and Wildlife Service 10(a)(1)(B) permit specifications, because targeted habitat includes areas known to be occupied by Stephens' kangaroo rat (*Dipodomys stephensi*) and San Bernardino kangaroo rat (*Dipodomys merriami parvus*). According to the same permit specifications, our first check will be near

midnight (Midnight) with a second check at sunrise (Dawn). At the Midnight check, traps will be reset with fresh bait as needed. In general, we will start the Dawn check at 0400, well before sunrise, to ensure captured animals are safe from exposure. Start time for Dawn check will be determined nightly and will take the time spent processing animals, removing millet before closing all traps, and driving between trapping grids into account. We will completely remove trapping grids on the final night of each effort by collecting traps, excess bait, and pin flags at the conclusion of the dawn check.

We will record the visit number, trap check (Midnight, Dawn), grid ID, recorder (3-letter initial), handler (3-letter initial), and start and end times (24 hour) of each grid check. We will also record moon phase (quarter, half, three-quarter, full, no moon), sky code (0 = Clear/Few Clouds, 1 = Partly Cloudy, 2 = Mostly Cloudy, 3 = Fog/Smoke, 4 = Light Drizzle, 5 = Constant Snow, and 6 = Constant Rain), and surface ground moisture (wet, dry) before checking each grid. Ambient-air temperature (C) will be recorded before leaving the grid. Two-member teams will check grids. The status of individual trap stations will be recorded on a quality-control form as either open, closed-empty, robbed, or missing. Traps containing animals will be recorded as the 4-letter species code of the animal captured. Team members will re-examine the quality-control form before leaving the grid to ensure that no traps have been missed.

We will process captured animals according to standard operating procedures developed by the Biological Monitoring Program for animal handling and data collection of small mammals (S:\Projects\Mammals\General_Protocols\Small_Mammal\SOP_General_SmallMammal_V.5). In general, for Covered Species, we will record weight (100-g Pesola spring scale), ear length (mm; tip to notch), hind foot length (mm), sex, age class (adult, juvenile), reproductive condition (non-reproductive, scrotal, pregnant, lactating, perforate, plugged), capture history (new, recapture), and trap location. We will mark the ventral surface of all Covered Species (RediSharp non-toxic permanent marker) upon initial capture, with a color unique to individual trapping efforts to indicate that the animal had been previously captured during that survey. We will release animals recaptured during an effort after recording species, trap location, and capture history. All non-covered species (e.g., *Peromyscus maniculatus*) will be released with no mark after trap location and species are recorded. Processing times will range between 30 s and 3 min, depending on the species and capture history. Only field personnel that have completed training from experienced Biological Monitoring Program staff will process animals.

Equipment

Grid Set-up

Each set-up team will have the following equipment:

- 1 wood stake (per grid)
- 2 or more 50-m tapes
- 25 pin flags (1 set per grid)
- **Admin Pass** (if applicable)
- At least 1 declinated compass
- Camera
- **Copy of Permit** (if applicable)
- Field maps
- Flagging tape
- GPS unit
- **Key for site access**
- Mallet
- Reflective tape
- Thick- or Chisel-tip Sharpie

Setting Traps and Baiting

Each member of the bait team will have the following equipment:

- **Admin Pass** (if applicable)
- Ant powder
- **Copy of Permit** (if applicable)
- Extra pin flags (5)
- Extra traps (2)
- Field Maps
- Flagging tape
- GPS unit
- Grid assignments
- **Key for site access**
- Large paper clips (5)
- Millet (1 bag per person)
- Reflective tape
- Thick- or Chisel-tip Sharpie

Checking Traps

Each team will have a trap kit (1 Mountain Smith pack) that contains the equipment listed below.

- 2 non-toxic markers
- 2, 100-g Pesola spring scales
- 2, 300-g Pesola spring scale
- 2, 6-in clear rulers
- 8 handling bags (gallon Ziploc)
- 8 trash bags
- **Admin Pass** (if applicable)
- Air horn (1 per person)
- Bear Spray
- Container of hand wipes
- **Copy of Permit** (if applicable)
- Copy of Protocol
- Extra headlamp batteries (per erson)
- Field maps
- Flashlight – high powered
- GPS unit
- Grid assignments
- Headlamp (1 per person)
- **Key for site access**
- Mortality forms
- Small bag of millet
- Tablet (1 per person)
- Thick- or Chisel-tip Sharpie
- Warm pack (if notified)
- 2 extra Sherman traps

TRAINING

Field staff will attend an on-line pre-survey training and complete a quiz developed by the Mammal Program Lead. The pre-survey training will include a slide-show presentation that details survey protocol, animal identification, and standard operating procedures for trapping small mammals. Crew members will take a quiz following the training seminar that covers presented material and must correctly answer all questions pertaining to identification of Covered Species.

Biologists in need of training will get hands on experience while we are actively surveying for LAPM. To accomplish this, the more experienced handler will train, how to properly handle each species and take the necessary measurements. The best way to train is on animals that are recaptures, that way if the animal escapes no data is lost. If the newly training biologist needs more experience before collecting data on new captures, roles will be reversed and the more experienced handler will continue to with animal captures while the other biologist will continue taking data.

Training Results

Field crew will be able to identify 7 covered and 7 non-covered small-mammal species in-hand after completing the above described training (Table 1). Crew personnel will also be able to safely and proficiently handle live animals and take measurements according to standard operating procedures (SOP) developed by the Biological Monitoring Program for animal handling and data collection of small mammals S:\Projects\Mammals\General_Protocols\Small_Mammal\SOP_General_SmallMammal_V.5). Moreover, field staff will be able to perform surveys for Los Angeles pocket mouse according to the protocol described in this document.

Table 1. Small-mammal species covered by Biological Monitoring Program training for Los Angeles pocket mouse surveys. Field crew must demonstrate the ability to correctly identify each of the 7 Covered Species and 7 non-covered species we are likely to capture.

Common Name	Scientific Name	Alpha Code
Covered Species		
Stephens' kangaroo rat	*Dipodomys stephensi*	DIST
Dulzura kangaroo rat	*Dipodomys simulans*	DISI
Aguanga kangaroo rat	*Dipodomys merriami collinus*	DMCO
San Bernardino kangaroo rat	*Dipodomys merriami parvus*	DMPA
Los Angeles pocket mouse	*Perognathus longimembris brevinasus*	PLBR
San Diego pocket mouse	*Chaetodipus fallax fallax*	CFFA
San Diego desert woodrat	*Neotoma lepida intermedia*	NLIN
Non-covered Species		
deer mouse	*Peromyscus maniculatus*	PEMA
brush mouse	*Peromyscus boylii*	PEBO
cactus mouse	*Peromyscus eremicus*	PEER
western harvest mouse	*Rethrodontomys megalotis*	REME
big-eared woodrat	*Neotoma macrotis*	NEMA
California pocket mouse	*Chaetodipus californicus*	CHCA
southern grasshopper mouse	*Onychomys torridus*	ONTO

DATA MANAGEMENT

Data Photos

After returning from setting up small mammal trapping grids in the field, surveyors will upload photographs of trapping grids to the proper folder; S:\Projects\Data_Photos\MammalTrapping

Grid\LAPM 2022 followed by the folder for the appropriate Core Area. Name data photos using the following convention: Date _GridID_Initals. Date format is YYYYMMDD, followed by 6 character GridID (i.e., ANVA01 not ANVA1), and 3-letter initials. Example 20220409 _SJRI01_JNH.

Surveyors will then enter the grid photo data to the database here; S:\Databases\Mammals. In S:\Databases\Mammals select the Grid Photos button under the Small Mammals tab. Choose Grid Setup then proceed to select the project (Los Angeles Pocket Mouse surveys), photographer, date photo was taken, Grid in the photo. This information will create the Photo ID. Include any pertinent comments, especially if the photo was taken in a way that varied from the protocol (i.e., camera was higher than 1.5m, large shrub in way so moved 2m to the West etc.).

Trapping Data

We will record field trapping data onto Access forms in a Tablet (NuVision model TM800W610L, Windows 10). Data will be exported daily from the Tablets into a spreadsheet where it can be queried for quality assurance by the Mammal Program Lead. We will append data to the MSHCP Biological Monitoring Program Database after quality assurance queries have been performed.

DATA ANALYSIS

Percent Area Occupancy

We will estimate grid-level occupancy (Ψ) and nightly detection probability (p) using data pooled across trap checks (e.g., midnight and dawn) within individual trap nights, and pooled across Core Areas surveyed with identical sampling densities. We will use program MARK to construct a set of candidate models for each sampling design that represents the full combination of site- (e.g., Core Area) and time-varying effects on p, and site-varying effects on Ψ (White and Burnham 1999). Candidate models will be based on a general closed-capture occupancy model that accounts for animals present but not detected (MacKenzie et al. 2006). We will address assumptions of closure by sampling grids over a consecutive 4-night period, and maintain independence of grid detections by enforcing a minimum spacing of 80 m between trapping grid centers. We will rank models in each set according to Akaike's Information Criterion (AIC), calculate Akaike weights (w_i), and consider parameter estimates averaged across the entire candidate set unless a single model shows clear support (i.e., $w_i > 0.9$) (Burnham and Anderson 2002). We will also calculate a cumulative detection probability (P^*) across each site according to the following formula where p_i is the model-averaged detection probability on a given night: $P^* = 1 - \prod_{i=1}^{3} 1 - p_i$. Variances for P^* will be calculated using the delta method (MacKenzie et al. 2006). We will extrapolate site-specific estimates of Ψ to the inference area of each Core Area to determine the acreage of occupied habitat.

Detection Modeling with Covariates

We will use program MARK to model the effect of calendar month, and average air temperature on p, and include Core Area as an attribute group to investigate the interaction between the covariates and site. We will include air temperature into our models because this parameter has been shown to affect activity of *Perognathus longimembris* in laboratory settings (French 1976, 1977). Calendar month is included to address unknown seasonal variables that may affect detectability.

We will pool data across the entire survey period, and construct a candidate set of models that represents the full combination of covariates, attribute groups, and nightly variation in p. We will rank candidate models according to AIC, calculate w_i for each model, and consider model-averaged estimates

and summed-total weights for each covariate across the entire candidate set, unless a single model shows clear support (i.e., $w_i > 0.9$) (Burnham and Anderson 2002). We will also back-transform parameter estimates from the logit scale, if variances are reasonable (i.e., 95 % confidence intervals do not include 0), and graph expected *p* against observed covariate values to further investigate site-specific differences in detection.

Population Trend

We will consider change in Percent Area Occupied (PAO) and relative abundance across years to assess whether Los Angeles pocket mouse populations are stable or increasing in Core Areas. We will examine change in PAO by pooling data across years from individual Cores, modeling Ψ with survey year as an attribute group, and examining estimates of occupancy following the model-selection criteria described above. Alternatively, we will compare 95% confidence intervals of estimated acreage of occupied habitat in each Core Area across years in the event that we adjust our habitat model between surveys.

We will also examine capture curves of Los Angeles pocket mouse across years on individual grids to determine if a similar proportion of available animals had been captured, thus allowing for comparable indices of abundance. We will then compare relative abundance between years at each Core Area using a paired-samples T-test, or a student's T-test if grids are redistributed between years.

SAFETY

Coyote Safety

In 2021, we encountered coyotes (*Canis latrans*) exhibiting non-normal behavior while trapping near Lake Perris. A number of hazing techniques were adopted in an effort to keep both field biologists and coyote safe. Please refer to the coyote safety protocol is located here: S:\Projects\Mammals\LAPM\LAPM_2022\LAPM 2022 Training\Coyote Safety Protocol_2022.

COVID-19 modification: We follow current COVID-19 precautions and follow guidelines set by the Occupational Safety and Health Administration (OSHA 2022). These procedures are to be consistent with and do not supersede other departmental Covid-19 Safety Procedures.

TIMELINE

2022

- March to April 2022: Protocol development. Training materials to field crew.
- 11 May: Remote presurvey training, PowerPoint presentation, quiz
- 17 to 20 May: Ground truth and install grids at San Jacinto Wildlife Area-Lake Perris Reserve (LPSJ) Core Area
- 23 to 27 May: survey LPSJ Core Area: 2 crews
- 6 to 1 June: survey LPSJ Core Area: 2 crews
- 31 May to 2 June: Ground truth and install grids at LPSJ Core Area
- 27 June to 1 July: survey LPSJ Core Area: 2 crews
- 25 to 29 July: survey LPSJ Core Area: 2 crews
- 15 to 19 August 1 to 17 June: Ground truth and install grids in San Jacinto River Bautista Creek Core Area
- 22 to 26 August: survey San Jacinto River Bautista Creek Core Area: 2 crews
- 29 August to 2 September: survey San Jacinto River Bautista Creek Core Area: 1 crew

- 12 to 16 September: Ground truth and install grids at Temecula Creek and Anza Valley Core Areas
- 19 to 23 September: survey Temecula Creek Core Area: 2 crews
- 26 to 30 September: survey Anza Valley Core Area: 2 crews
- October to December 2022: data entry, data quality control, data analysis
- January to March 2023: report writing

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