Assessment of Night-Flying Forest Pest Predator Communities on Demonstration State Forests


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Jointly-funded by CAL FIRE Resource Management & the BoF Effectiveness Monitoring Committee


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First Field Season (2019) Update

Jackson Demonstration State Forest

Effectiveness Monitoring Committee

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INTRODUCTION & BACKGROUND

Because bats in N. America are nocturnal, generally small, & cryptic, they easily escape our attention

- Forester: "I've worked these woods for 40 years & I've never seen a bat."
- > 1,400 species worldwide (= 20 - 25% of all mammal species)
- Every continent except Antarctica; Greatest diversity in the tropics, decreases w/ latitude; known from almost all major habitat types
- ~140 species in Mexico; ~50 spp. (& subspecies) in the U.S. & Canada
- ~23 species in California, ~17 species inhabit CA forests

17 'forest bat' species in CA; most are 'of concern'; none are listed under ESA or CESA

(There are listings occurring in the East due to white nose syndrome impacts)

INTRODUCTION & BACKGROUND

Bats eat enormous amounts of insects

- Primary predators of moths & beetles, many of which impact tree growth
- Bats provide $29.9 & $53 billion/year in cotton & corn pest-control, respectively (Boyles et al. 2011, Mayne & Boyles 2015)
- Bat pest-control value to the forest products industry is unknown, but is potentially significant

Insects & disease impact forest productivity

- > 450 non-native insects & diseases, many spread by insects, are well-established in US forests (USFS)
- These pathogens cause ~12 million tons of annual tree mortality in US forests (USFS)
- The total amount of carbon in these decaying materials is comparable to annual carbon emissions from 4.4 million cars (USFS research)

INTRODUCTION & BACKGROUND

Bat populations are declining in CA & beyond

The Washington Post
Democracy Dies in Darkness

A deadly fungus is driving these bats near extinction, government says

The U.S. Fish and Wildlife Service is proposing listing the tricolored bat as endangered after its population declined due to white-nose syndrome

By Dino Grandoni
September 13, 2022 at 8:45 a.m. EDT

Bats are an important part of Northern California's ecosystem, but their population is declining

A local bat conservation expert says the number of bats in the region has dropped over the past 50 years, mainly because of habitat loss. That could lead to an increase in insects and other pests.

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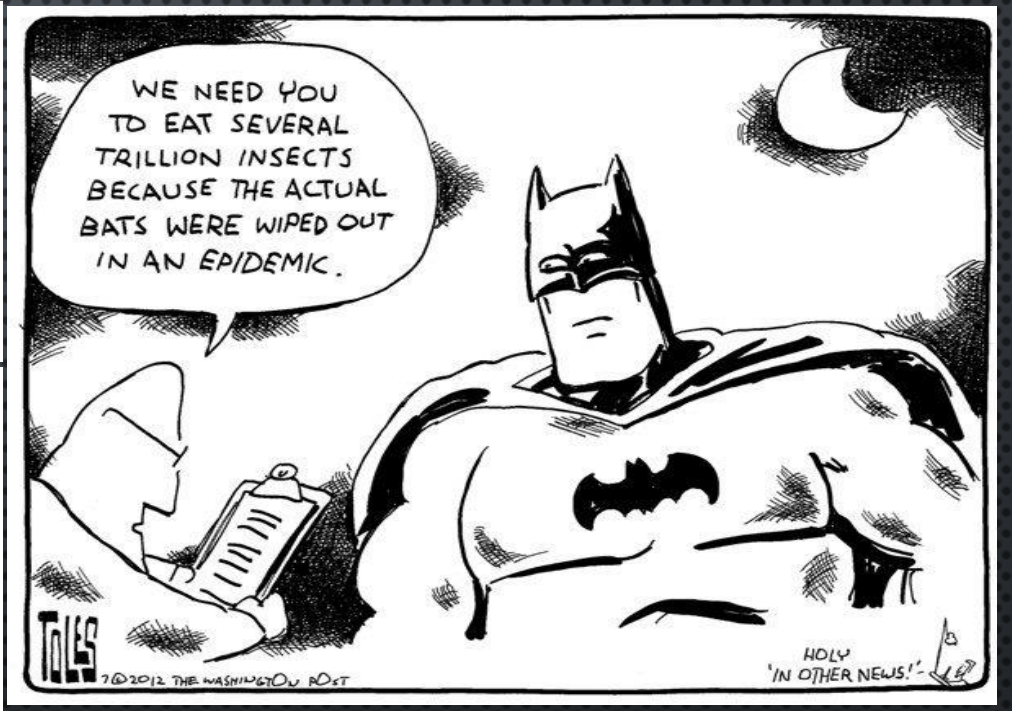
Updated: 5:05 PM PDT Jul 20, 2022



Nationally, several million of bats have died due to an introduced 'cold-loving' fungus that disrupts water balance & hibernation, since 2006

"It (WNS) is the most severe wildlife disease in recorded history"

- Chris Cornelison, microbiologist, Georgia State University & USFS

STUDY OBJECTIVES & DESIGN

Most studies/surveys try to maximize detections

- Our sampling sites are intentionally selected to be >100 m from bat travel corridors or drinking sites
- **Our study attempts to sample within forest stands used for foraging of night-flying insects by bats**

Previous studies typically test for bat community differences between recent harvest & mature stands

- Local-scale habitat data will be collected at each detector site (*future JDSF field work*); other available data will be compiled
- **On JDSF, our study will test for differences in bat communities between mature stands (i.e., >50 yrs) & the oldest stands available**
- Future analyses will assess relationships between bat activity & forest habitat across all 4 study areas (DSFs) to determine stand characteristics that most impact bat species presence

STUDY OBJECTIVES for the EMC

Monitoring Question: Are the FPRs effective in promoting habitats suitable to forest bat communities that prey on forest insects?

FPRs and Regulations:

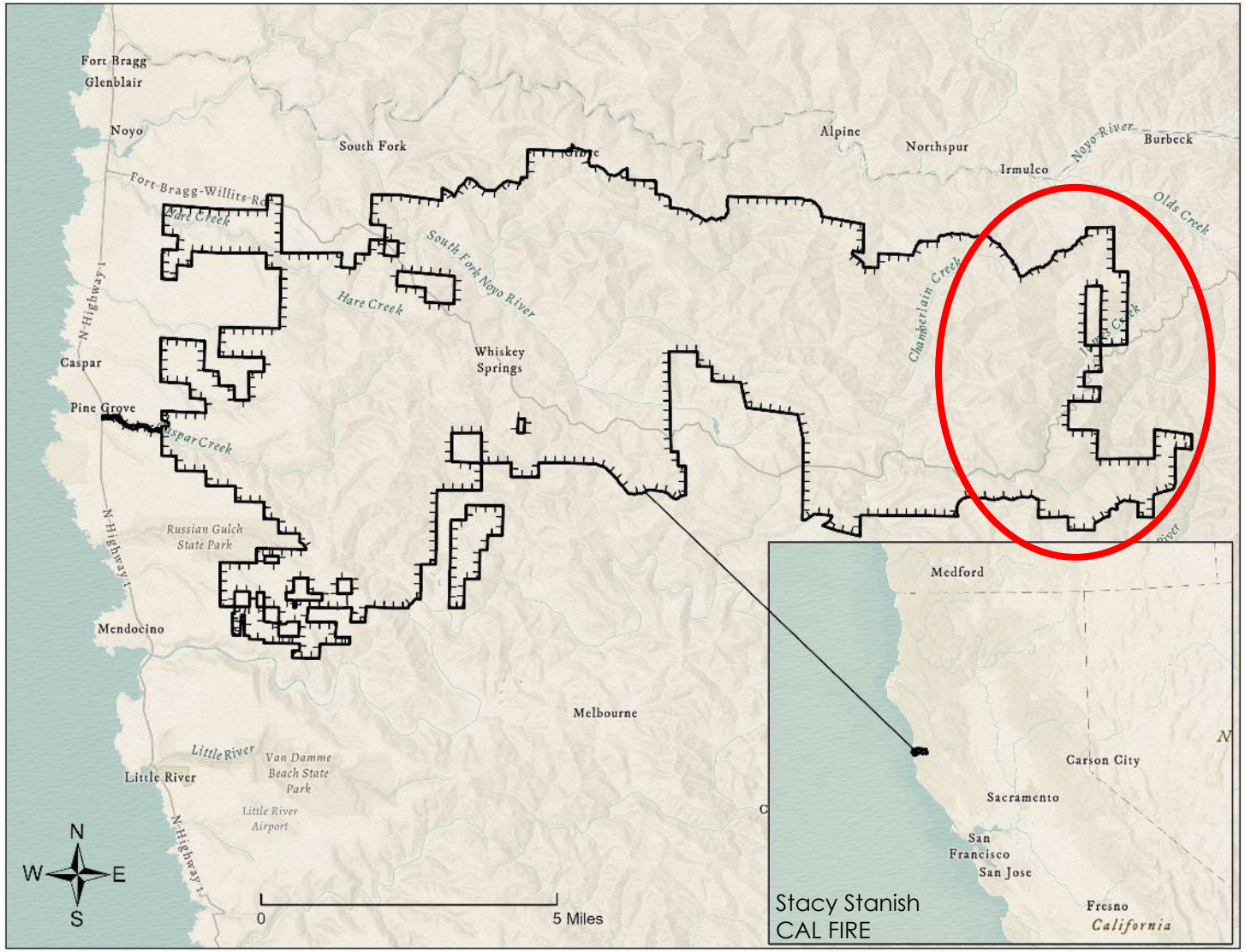
14 CCR § 897; 14 CCR § 912.9 (932.9, 952.9); 14 CCR § 913.4 (939.4, 959.4); and 14 CCR § 919 (939, 959).

EMC Critical Questions or Priorities:

- Theme 7: Wildlife Habitat: Species and Nest (Roost) Sites
  (i.e., species presence among DSFs).
- Theme 8: Wildlife Habitat: Seral Stages
  (i.e., species presence across seral stages/silvicultural prescriptions).
- Theme 10: Wildlife Habitat: Structures
  (i.e., species presence, indicative of roost structure availability).

STUDY AREA (Late May thru Early November 2019)

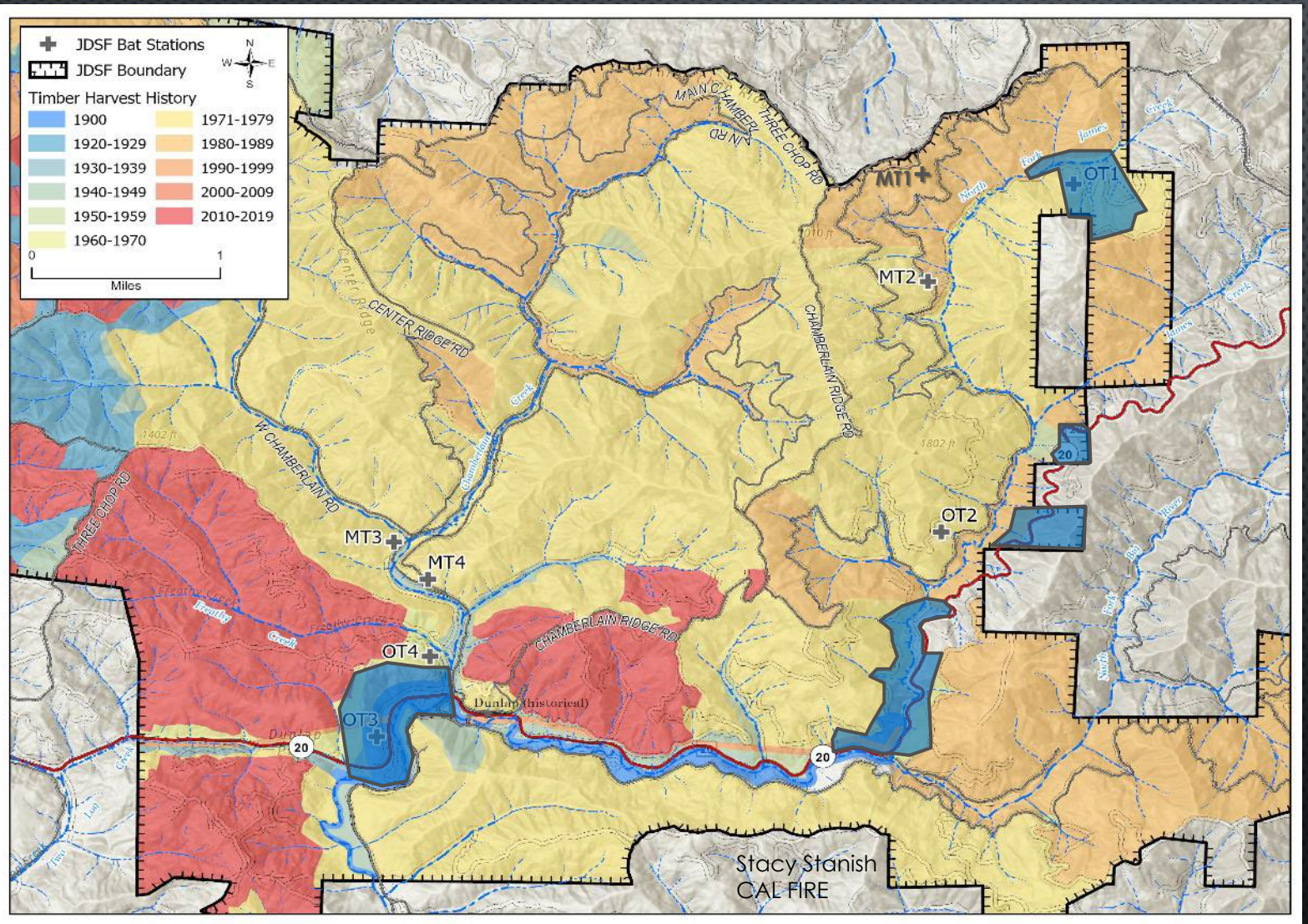
Jackson Demonstration State Forest



- Selected the eastern portion of JDSF, due to:
- Availability of isolated older-growth groves
- In proximity to mature stands last harvested in the 1960s & 70s, &
- With available road infrastructure

ACOUSTIC DETECTION STATIONS

Eastern (inland) portion of Jackson DSF



- Reduced influence of coastal meteorology
- James Creek and Chamberlain Creek
- 2 'older-growth' & 2 'mature-trees' sites per creek system
- Detectors >100m from roads/waterways

ACOUSTIC DETECTION STATIONS

Methods

- Wildlife Acoustics 'SM4Bat' full-spectrum acoustic detection units
- Extendable poles & cheap bungee cords
- Waterproof Ultrasonic microphones
- Bat detectors sample airspace out to ~30m
- 8 bat detectors allows n = 4 replicates of 2 gross-level forest condition categories

INSECT SAMPLING

Methods

- Used 10W black light traps with dichlorvos-based “pest strips” to subdue captured specimens
- Sampled each bat detector site 4 times
- Identified specimens as specifically as possible & collapsed data to Family level

* - these are ‘availability’ data as no ‘bat diet’ data were collected

ANCILLARY BAT CAPTURE EFFORTS

Least important, but most 'fun', project activity; attempts will continue on other forests (& maybe on JDSF)

- The plan was to attempt bat capture during monthly trips to download data & replace bat detector batteries
- Intention was to locate reliable capture sites prior to inviting folks to participate for demonstration purposes
- This typically requires capture attempts at numerous sites before reliably productive sites are located (&= true again here)
- We determined that a more intensive capture effort will be required to find sites for capture demonstration purposes

RESULTS Acoustic Detection

- **166** nights; 72,555 sound files; **48,248** (66.5%) w/ 'bat tonal info'
- Range = 2,839 - 11,875 (means = **17.1** - **71.5** bat calls/night/site)
- Bats w/ characteristic frequencies above 30kHz (= "Hi-F" species) detected **>4 times** more than "Lo-F" bats (**104** vs. **27** calls/night).
- Hi-F bats are better-adapted for foraging w/in more 'cluttered' airspace than Lo-F bats, which forage in more 'open' airspace.
- Bat calls (& both Hi-F & Lo-F) were detected on each night from w/in 1 hour after local sunset to w/in 1 hour before local sunrise.
- Bat activity was highest in August (430 calls/night), followed by July (323), June (322), September (245), & October (165).

RESULTS Acoustic Detection

- **12,765** bat call files were conservatively classified to species level among **7 species** by SonoBat software (v4.2.2).
- **439** other bat call files required manual vetting for potential inclusion in species-level data. These are analyzed separately.
- The most commonly detected species, **by >10x to 41x**, were **California myotis** (*Myotis californicus*), on **98.8%** of **166 nights**.
- California myotis, a 'Hi-F' species, were detected, on average, **x = 60.7 per night across all sites** (range = 0 – 380 / night).
- **Silver-haired bats** (*Lasionycteris noctivagans*), a 'Lo-F' species, were 2nd most detected (**x = 5.8 per night**; range = 0 – 52 / night).

RESULTS Acoustic Detection (conservative classifications)

Species (*Latin name*)	Freq. group	% (#) Nights	Dets/night (range)	Sites
California myotis	Hi-F	98.8 (164)	60.7 (0 – 380)	All
silver-haired bat	Lo-F	70.5 (117)	5.8 (0 – 52)	All
hoary bat (*Lasiurus cinereus*)	Lo-F	80.1 (133)	3.7 (0 – 25)	All
Brazilian free-tailed bat (*Tadarida brasiliensis*)	Lo-F	75.3 (125)	2.0 (0 – 13)	All
fringed myotis (*Myotis thysanodes*)	Lo-F	59.6 (99)	1.7 (0 – 18)	7 of 8
western long-eared myotis (*Myotis evotis*)	Hi-F	69.3 (115)	1.6 (0 – 22)	All
big brown bat (*Eptesicus fuscus*)	Lo-F	52.4 (87)	1.5 (0 – 18)	All

RESULTS Acoustic Detection (less-confident classifications)

- Among the **439 bat call files** that required manual vetting…
- SonoBat tentatively classified calls as <u>likely</u> from **6 other species**.

Yuma myotis (*Myotis yumanensis*)	*N* = 201 files;	n = 4 (confident)
hairy-winged myotis (*Myotis volans*)	*N* = 147 files;	n ≥ 1 ('possible')
western red bat (*Lasiurus blossevillii*)	*N* = 33 files;	n = 0 (vy. difficult)
Townsend's big-eared bat (*Corynorhinus townsendii*)	*N* = 23 files;	n ≥ 1 ('possible')
little brown myotis (*Myotis lucifugus*)	*N* = 21 files;	n = 4 (confident)
pallid bat (*Antrozous pallidus*)	*N* = 14 files;	n ≥ 1 ('possible')

- **Yuma & little brown myotis** (both Hi-F) **were confidently added** to the **'species present' list**. Both species tend to forage near water.

RESULTS Species possibly detected/present

➢ hairy-winged (long-legged) myotis

- 6 - 9g; ~11" wingspan
- Consume moths +
- **Roost** in crevices & **under exfoliating bark on pine snags**
- Range throughout California
- Special concern

➢ Townsend's big-eared bat

- 8 - 14g; ~13" wingspan
- **Very 'quiet' echolocators**
- Consume moths +
- Roost in basal hollows, caves, & mines
- Range throughout California
- Special concern

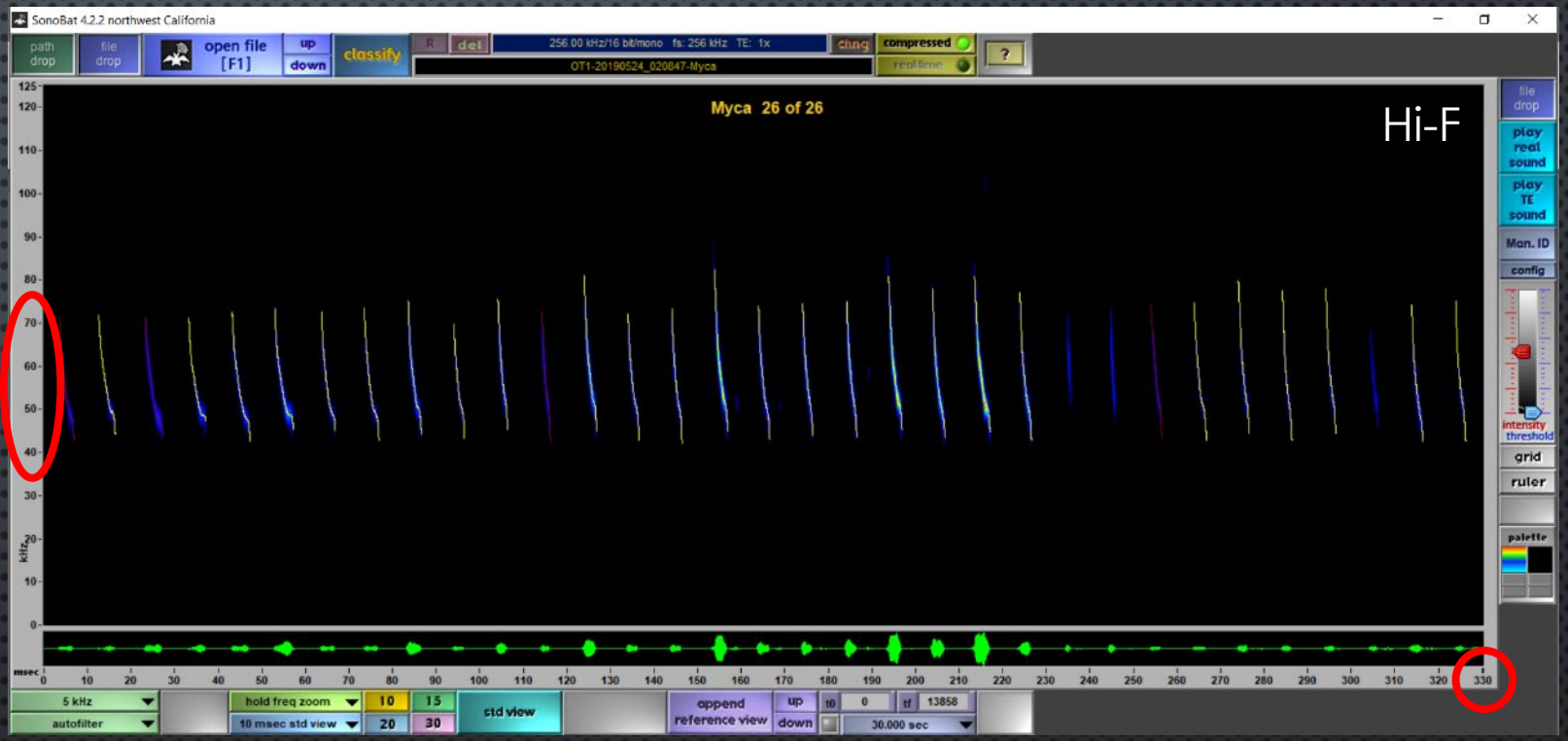
➢ western red bat

- 10-15g; ~12" wingspan
- Riparian habitats with hardwoods
- Roost in foliage
- **Tend to produce twin pups**
- Range throughout California
- Special concern

➢ pallid bat

- 20 - 35g; ~15+" wingspan
- Most common in arid & rocky scrub habitats
- Glean lg. prey, including **scorpions,** from low veg.
- Roost in basal hollows, rocks, & mines
- Range throughout California (**CA state bat?**)

RESULTS Acoustic Detection



- **California myotis** & sonogram of a representative call sequence
- Typically weigh 3 to 5 grams; 9 to 10” wingspan; forearms < 36 mm
- Specimens are known from every county in California
- Consume Diptera, Lepidoptera, Trichoptera, & small Coleoptera
- Day-roost in cracks, crevices, hollows of ‘damaged’ trees & snags

RESULTS Acoustic Detection

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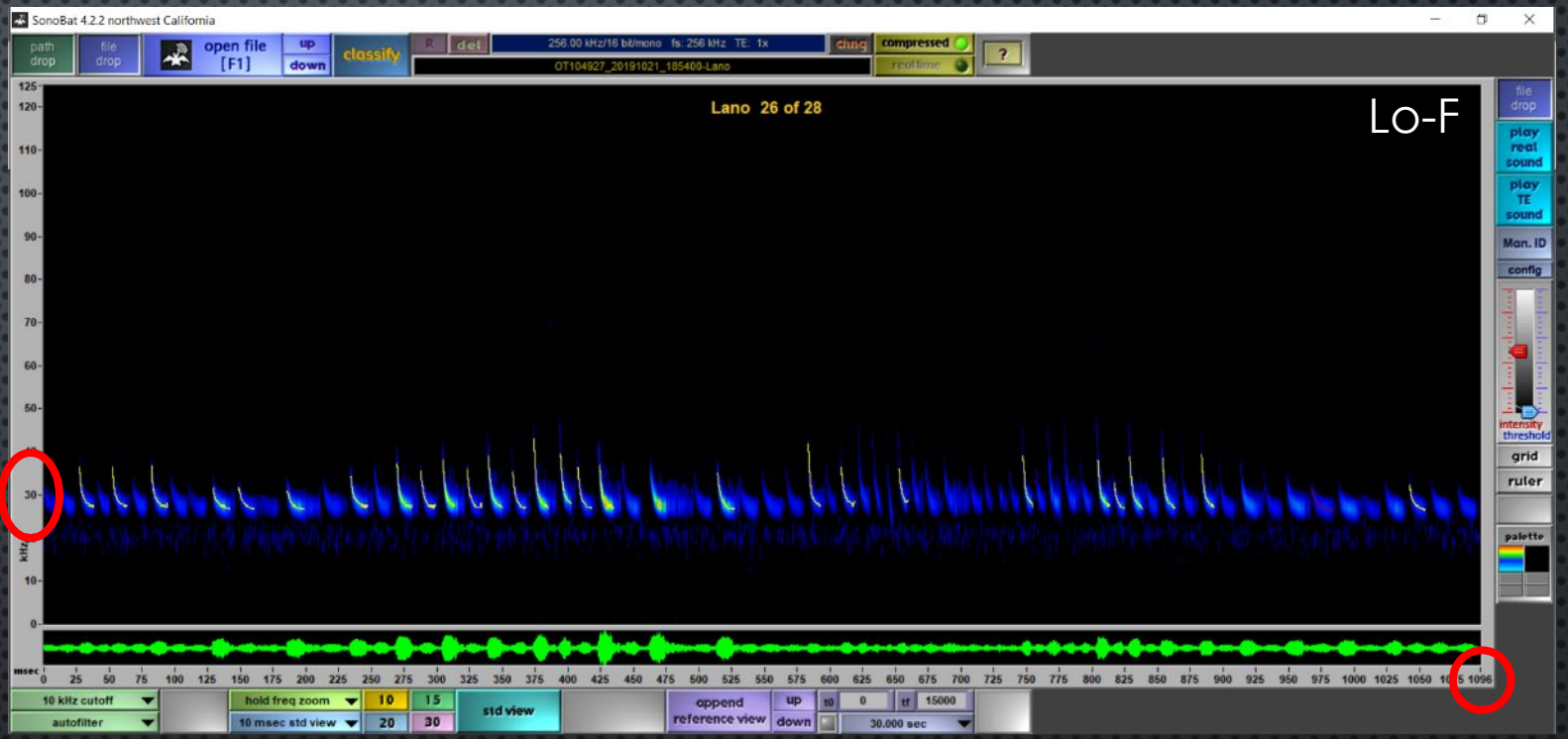
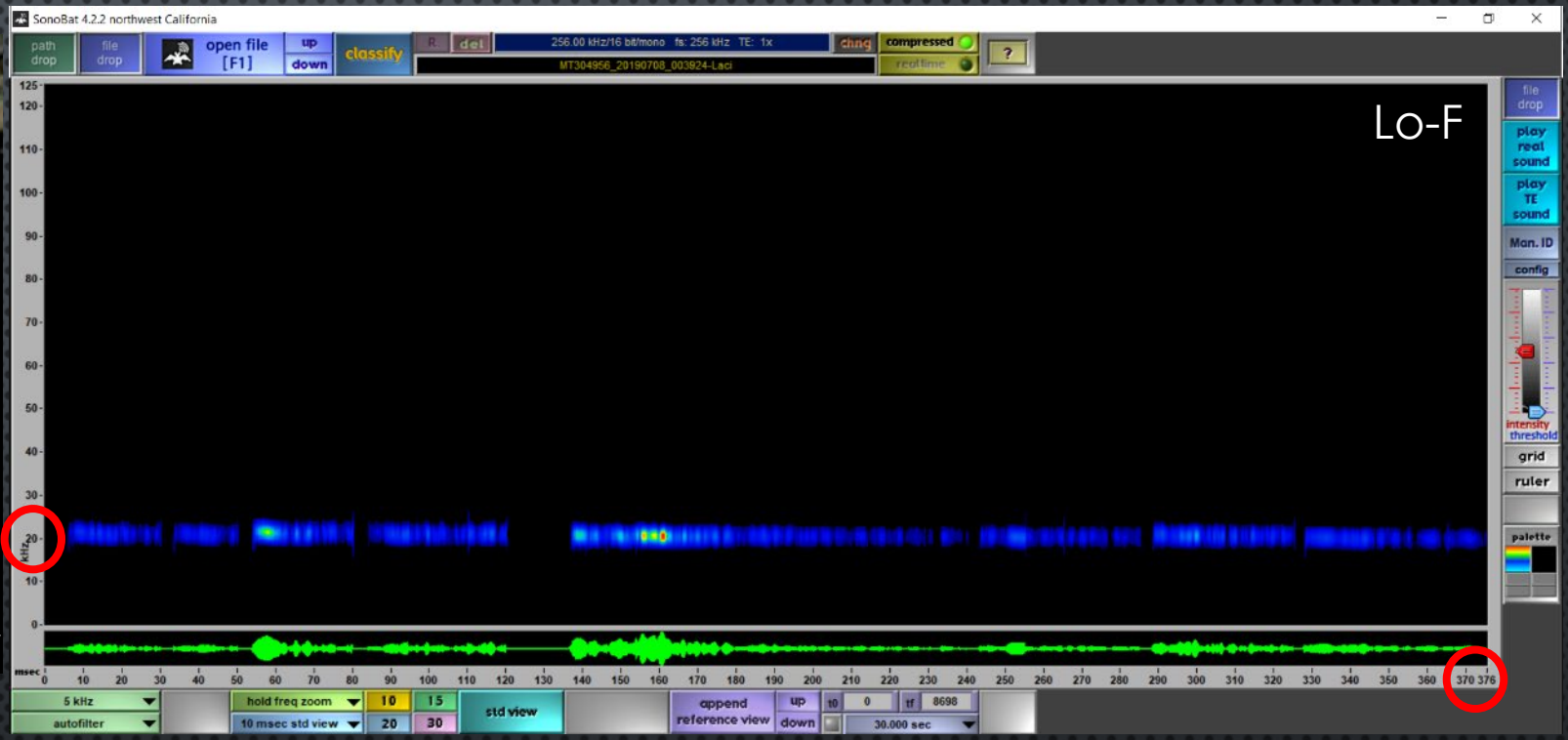


- **silver-haired bat** & sonogram of a representative call sequence
- Typically weigh 8 to 11g; ~12" wingspan; 37 to 44 mm forearms
- Range across all California forests, excluding the central coast
- Consume 11 Orders; mainly Lepidoptera, Diptera, & Trichoptera
- Day-roost in 'damaged' trees, snags, & w/in live conifer foliage

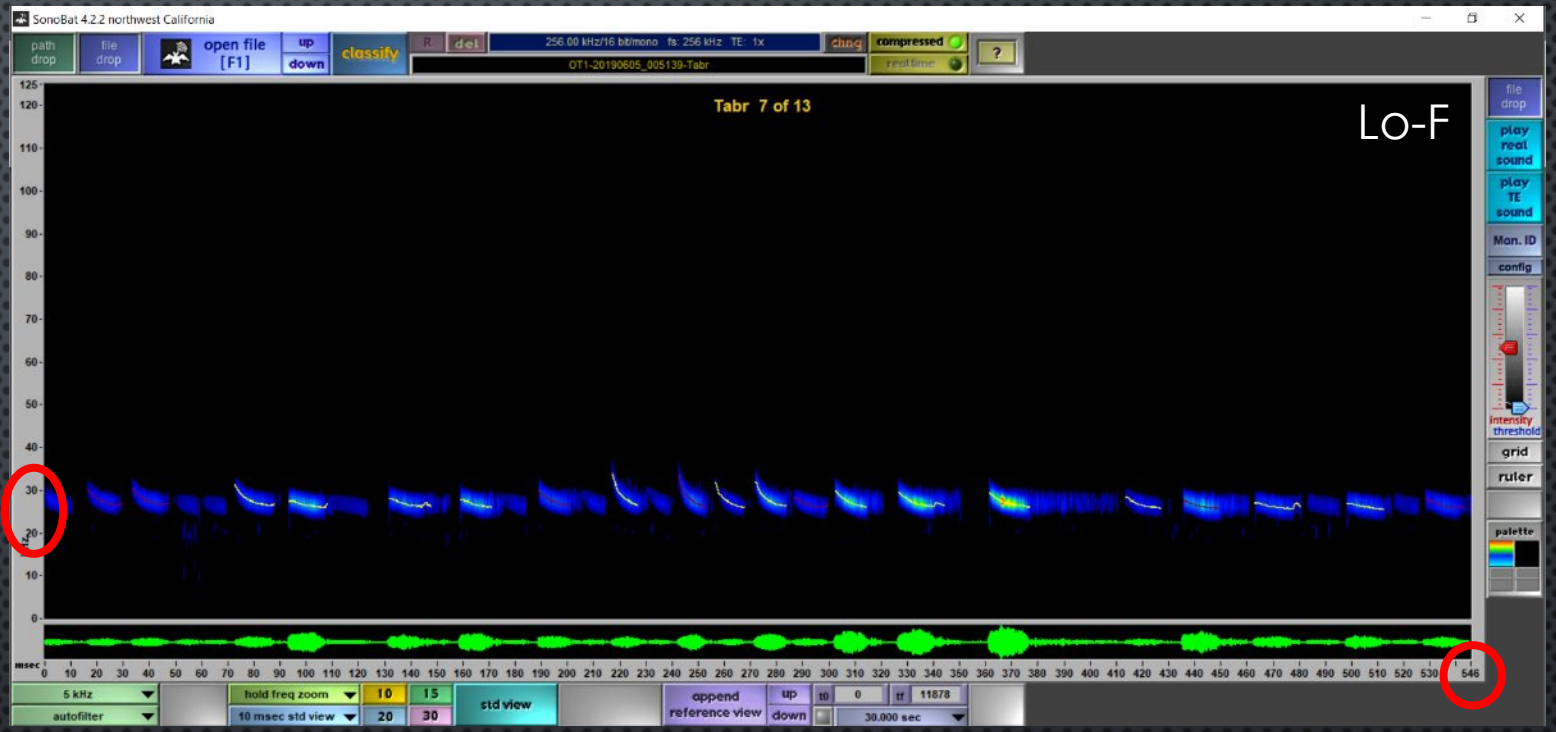
RESULTS Acoustic Detection

Photo credit: Michael Durham/Minden Pictures, Bat Conservation International



- **hoary (frosted) bat** & sonogram of a representative call sequence
- Typically weigh 25-30g; 13 to 16” wingspan; 46 to 58 mm forearms
- Range across all California forests, excluding SE plateaus & deserts
- Consume large Lepidoptera, Coleoptera, Hemiptera, & Araneae
- Day-roost in ‘damaged’ trees, snags, & w/in live conifer foliage

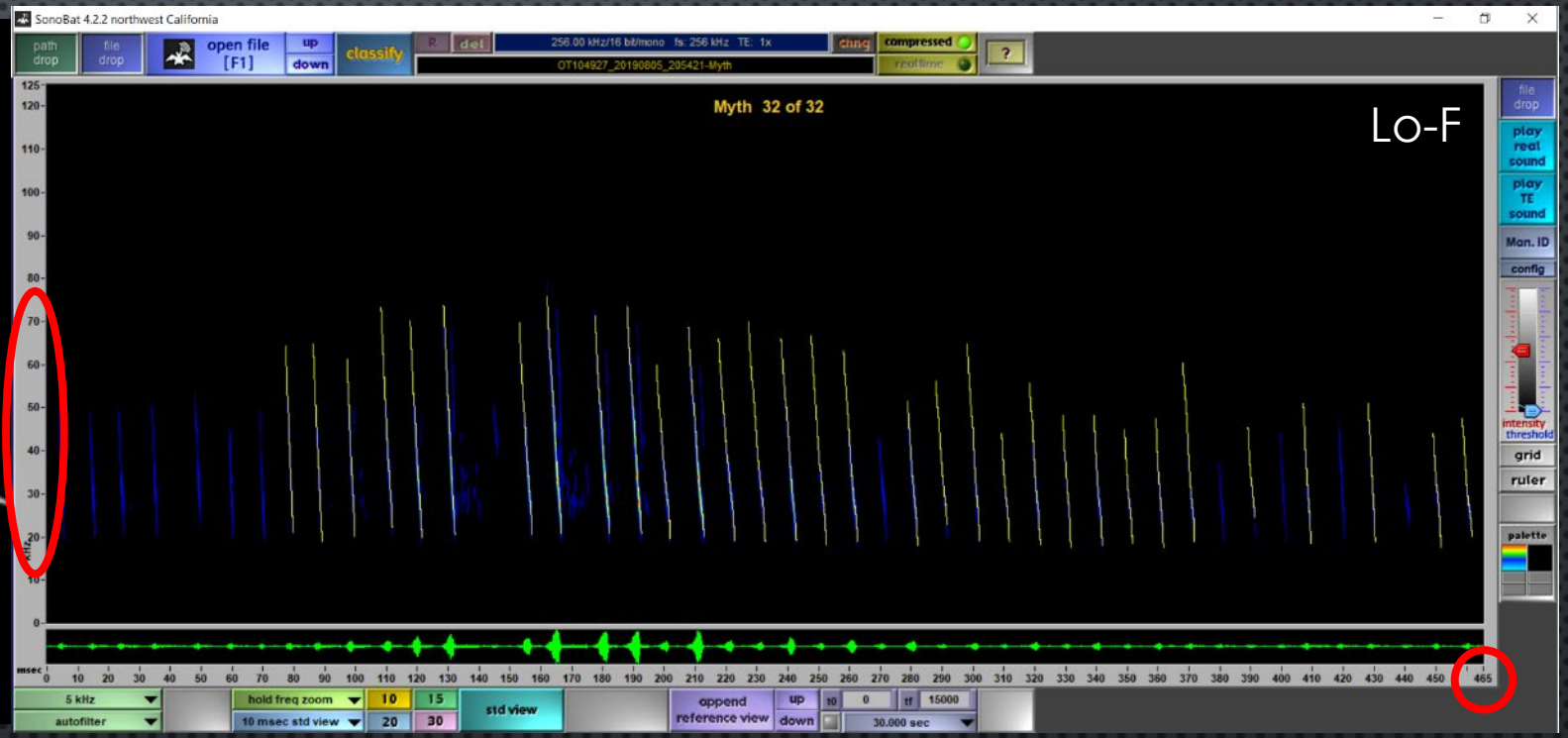
RESULTS Acoustic Detection



- **Brazilian free-tailed bat** & representative call sequence sonogram
- Typically weigh 11 to 15g; ~13" wingspan; 36 to 46 mm forearms
- Range across all California forests & occur w/in many urban areas
- Consume Diptera, Coleoptera, Hemiptera, & Neuroptera
- Day-roost in 'damaged' trees, snags, & anthropogenic structures

RESULTS Acoustic Detection

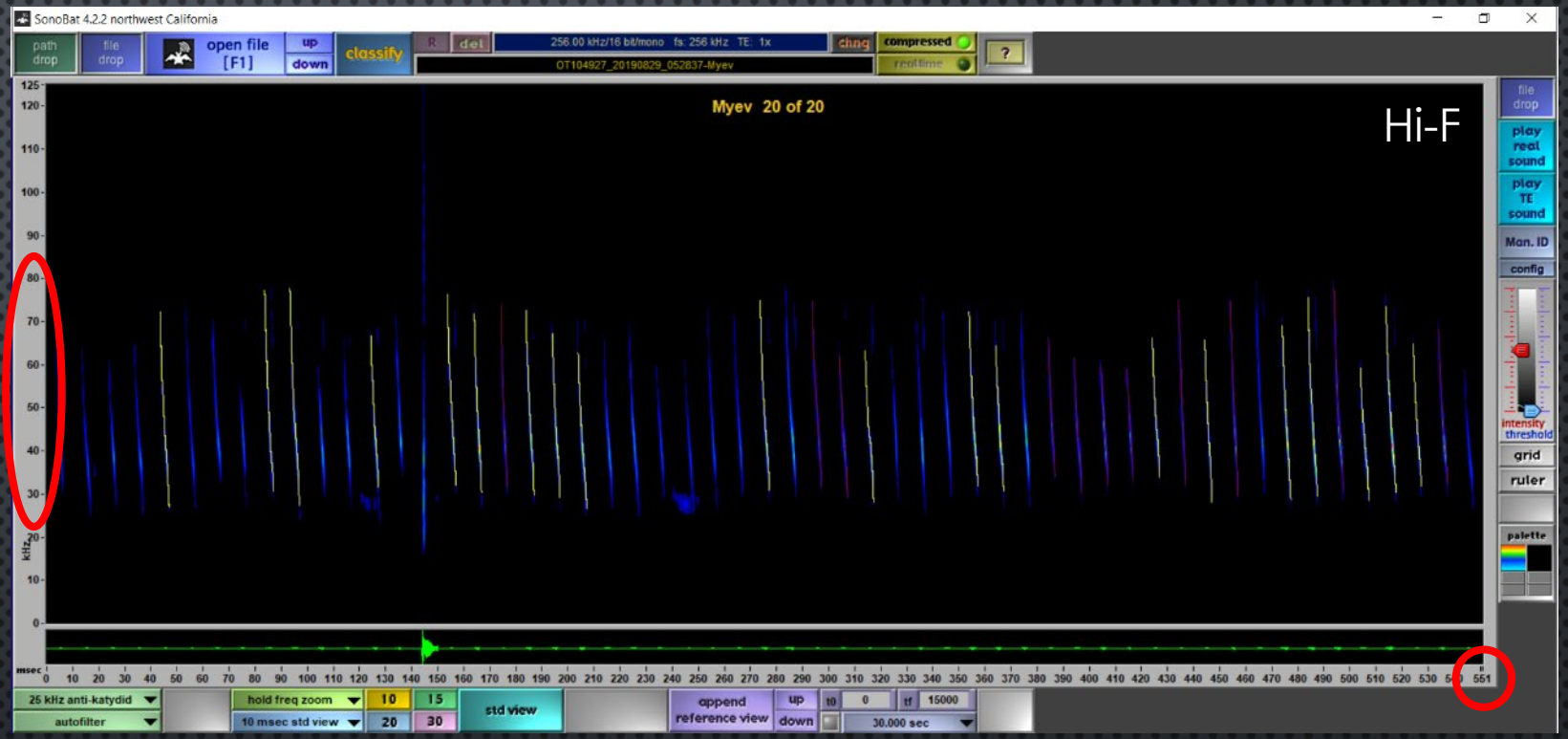

Photo credit: J. Scott Altenbach



- **fringed myotis** & representative sonogram of a call sequence
- Typically weigh 6 to 8g; ~12" wingspan; 36 to 39 mm forearms
- Range across all forested portions of California
- Consume Lepidoptera, Coleoptera, Hemiptera, & Araneae (+)
- Day-roost in 'damaged' trees, snags, talus slopes & rock outcrops

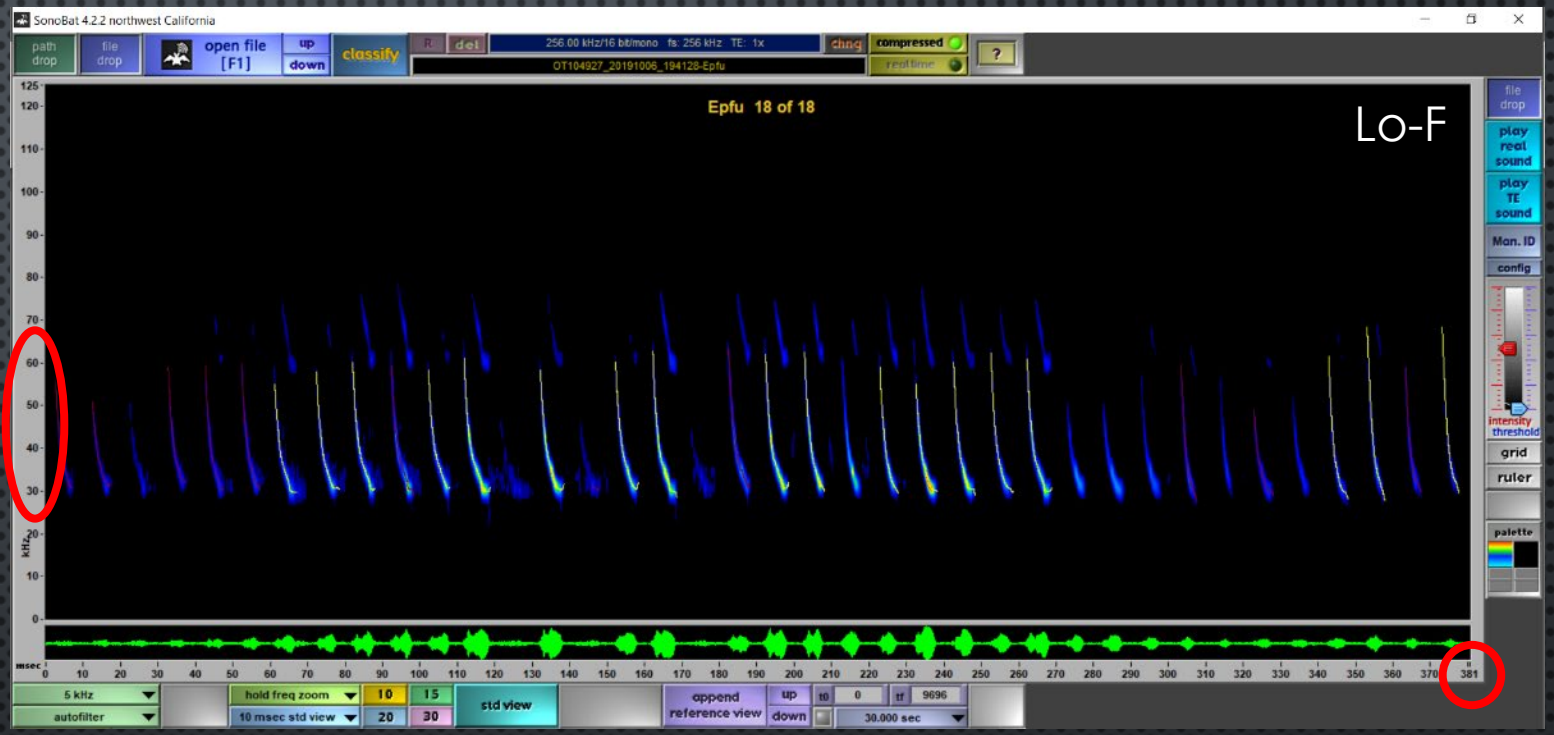
RESULTS Acoustic Detection

Photo credit: Michael Durham/Minden Pictures, Bat Conservation International



- **western long-eared myotis** & sonogram of representative calls
- Typically weigh 6 to 8g; ~11" wingspan; 36 to 39 mm forearms
- Range across all forested portions of California
- Consume Lepidoptera, Coleoptera, Hemiptera, & Araneae (+)
- Day-roost in 'damaged' trees, snags, talus slopes & rock outcrops

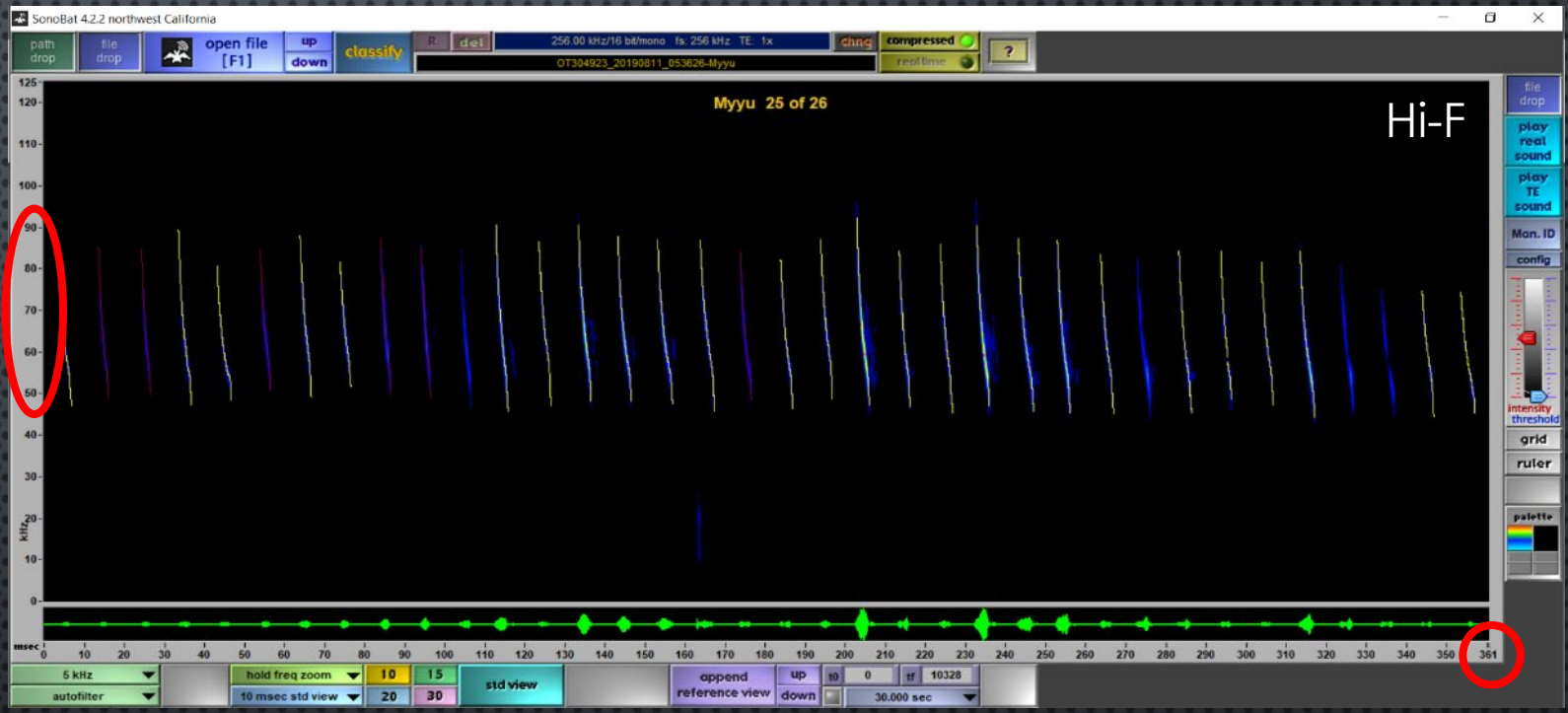
RESULTS Acoustic Detection



- **big brown bat** & representative sonogram of a call sequence
- Typically weigh 14 to 21g; 13 to 16” wingspan; >42 mm forearms
- Range throughout all areas of California, forested & not forested
- Consume large Lepidoptera, Coleoptera, Hemiptera, & Araneae
- Day-roost in ‘damaged’ trees, snags, & anthropogenic structures

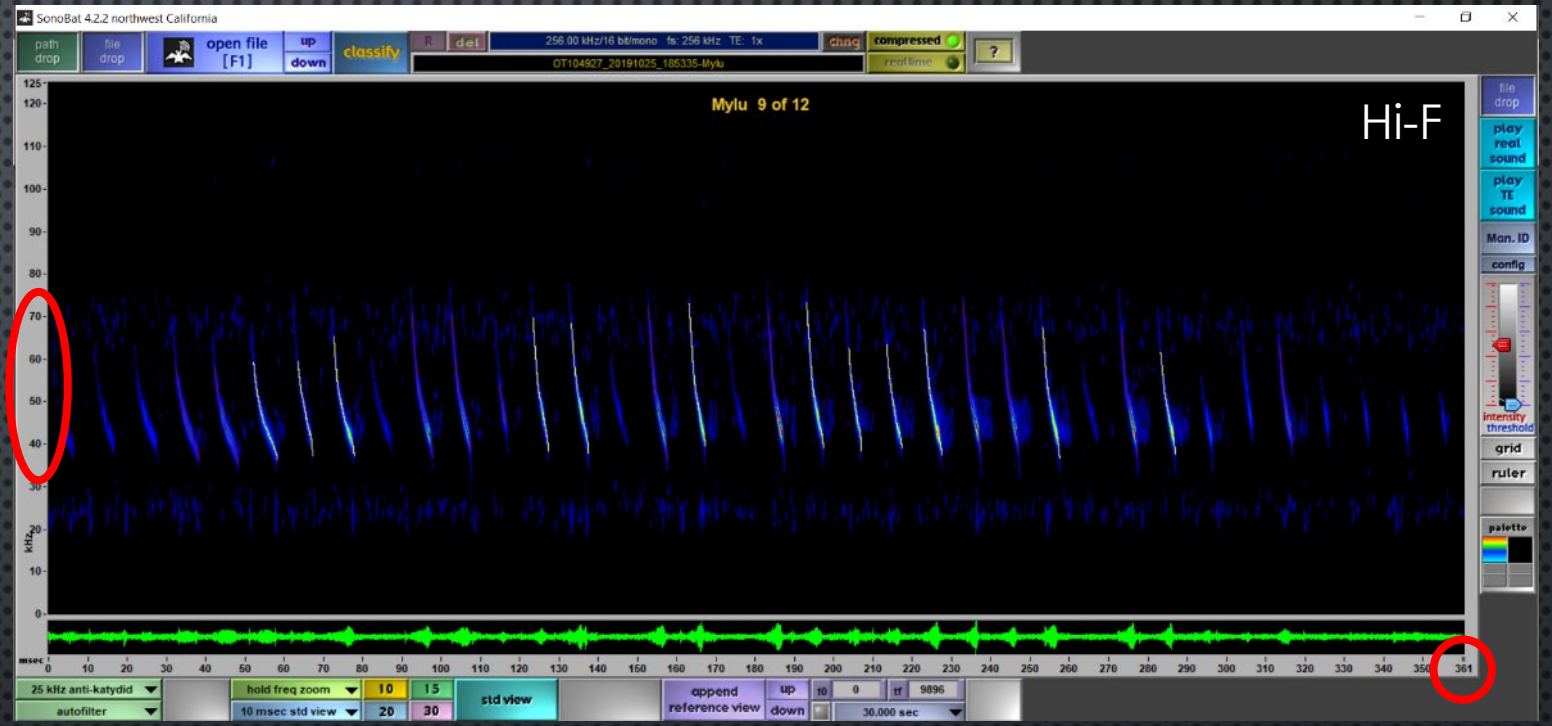
RESULTS Acoustic Detection

Photo credit: Michael Durham/Minden Pictures, Bat Conservation International



- **Yuma myotis** & representative sonogram of a call sequence
- Typically weigh 7 to 9g; 9 to 10” wingspan; 33 to 39 mm forearms
- Range throughout all areas of California, forested & not forested
- Consume large Diptera, Coleoptera, Hemiptera, & Neuroptera
- Day-roost in ‘damaged’ trees, snags, & anthropogenic structures

RESULTS Acoustic Detection



- **little brown myotis** & representative sonogram of a call sequence
- Typically weigh 7 to 9g; 9 to 11" wingspan; 33 to 39 mm forearms
- Range across the high Sierra & all forested areas of California
- Consume 9 Orders incl. Diptera, Trichoptera, Lepidoptera, et al.
- Day-roost in 'damaged' trees, snags, & anthropogenic structures

RESULTS

Insect Sampling (the Moths)

Lepidoptera (Moth Families)	# Collected	% of Total	Months	Sites
Noctuidae ('owlet' moths)	442	22.2	May - September	All
Micro-Lepidoptera	382	19.2	June - September	All
Geometridae ('loopers, pug, wave, emerald, & carpet' moths)	328	16.5	May - September	All
Erebidae ('underwing' moths)	262	13.2	May - September	All
Crambidae ('snout' moths)	226	11.4	May - September	All
Tortricidae ('leafroller' moths)	80	4.0	May - August	All
Lasiocampidae ('tent caterpillar' moths)	63	3.2	May (only)	All
Pyralidae ('snout' or 'grass' moths)	29	1.5	May, June, August	7 of 8
5 other Families*	13	0.7	May, June, August	7 of 8

* - Tineidae, Saturniidae, Megalopygidae, Notodontidae, & Limacididae

RESULTS Insect Sampling

RESULTS

Insect Sampling (Other than Moths)

Other Orders	# Collected	% of Total	Months	Sites
Coleoptera (beetles)	112	5.63	May - September	All
Hymenoptera (sawflies, wasps, & bees)	18	0.90	May, June, August	6 of 8
Diptera (flies)	10	0.50	June, July, August	5 of 8
Neuroptera (lacewings)	10	0.50	June, July, August	6 of 8
Isoptera (termites)	5	0.25	August (only)	2 of 8
Aranae*	2	0.10	June, July	2 of 8

(* - true spiders; not insects)

The majority of forest tree pests belong to the Orders **Lepidoptera** & **Coleoptera**. Among the Lepidoptera, numerous conifer tree pests belong to the Families **Noctuidae**, **Geometridae**, & **Tortricidae**. JDSF is home to these Orders & Families (among those of other forest tree pests) & also to their night-flying predators.

RESULTS Ancillary Bat Capture efforts

- We attempted bat capture at 3 sites over 4 nights (May-July)
- We captured only 2 bats on 1 night
- Both were non-reproductive adult male **California myotis**

Dorus Van Goidsenhoven
CAL FIRE

- **Least 'important' aspect of the study**
- **Most potentially enjoyable aspect of the study**
- **Future demonstration capture efforts intended**

DISCUSSION Study Limitations:

- Our data should not be extrapolated beyond the specific habitats targeted by our sampling scheme (i.e., within lower-canopy, mature coastal redwood-dominated, mixed conifer stands >15 mi. from the coast)
- Other habitat types/canopy strata on JDSF likely support differing bat species assemblages & activity levels
- #s of calls index relative activity, rather than absolute # of bats
- Bats adjust their echolocation calls relative to purpose, environment, & soundscape; conservative ID is advised
- The physics of ultrasound propagation, attenuation, & detection are confounding relative to factors above (see discussion in progress report)
- Less common or 'quiet' species may remain undetected

DISCUSSION Primary JDSF Findings:

- We verified an enormous amount of nightly bat activity between late May & early November at all JDSF sites
- We verified the presence of a minimum of **9** bat species foraging w/in the lower canopy of mature stands on JDSF
- Nightly bat activity started w/in 1 hr. of local sunset & continued to w/in 1 hr. prior to local sunrise, thus suitable day roosts exist in relative proximity to sampling sites
- We verified the presence of a minimum of **6** insect Orders & **13** moth Families on JDSF, w/in which a minimum of **66** forest tree insect pest species are known from California

PRELIMINARY STUDY PROGRESS ASSESSMENT

Monitoring Question: Are the FPRs effective in promoting habitats suitable to forest bat communities that prey on forest insects?

- Habitats suitable to forest bat communities that prey on forest insects have been promoted & exist on JDSF under the FPRs

EMC Critical Questions or Priorities:

- Regarding Theme 7: Wildlife Habitat: Species & Nest (Roost) Sites
  A minimum of 9 bat species documented; Roost sites are inferred
- Regarding Theme 8: Wildlife Habitat: Seral Stages
  The future Final Report will address this Theme for all DSFs studied
- Regarding Theme 10: Wildlife Habitat: Structures
  Extensive bat activity w/in 1 hr. of local sunset through 1 hr. of local sunrise indicates relatively nearby roost structure availability

NEXT STEPS

The project has been moved to Mountain Home Demonstration State Forest & data collection (acoustic detection) is well underway

Insect trapping & bat capture attempts have not yet been possible at MHDSF due to delay in acquiring renewal of our SCP & logistics would be extra difficult

Future progress reports will mirror the current report for each DSF, & incorporate background information in past reports by reference

Future analyses will compare species presence among seral stages & silvicultural prescriptions &/or assess other local habitat management questions

The final report will aggregate the results from all 4 DSFs & include analyses of habitat measures among seral stages, silvicultural history, and local & landscape-level habitat measurements

Thanks to: Funders, Jackson DSF, Stacy Stanish, Roberta Lim, Dorus Van Goidsenhoven, Peter Rowland, +++