# Indigenous Burning Prescribed Fire, and Goldspotted Oak Borer Management Potential

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CAL FIRE Forest Health Research Program Grantee Webinar

# *Agrilus auroguttatus* - Goldspotted Oak Borer

- 2004 discovered in east San Diego County [1]
- 2008 Linked to oak mortality[2]
- Estimated time of arrival 1990's[3]

Photo Credit: Mike Lewis

1. Coleman TW, Seybold SJ (2008a) New pest in California: the goldspotted oak borer, Agrilus coxalis Waterhouse. USDA Forest Service, Pest Alert, R5-RP-022, 28 Oct, 2008, 4 pp
2. Coleman TW, Seybold SJ (2008b) Previously unrecorded damage to oak, Quercus spp., in Southern California by the goldspotted oak
3. Hishinuma, Stacy. 2020 personal conversation

# La Jolla Indian Campground

30 miles northwest, 15 years later, 900 dead trees in the past 4 years on 200 acres

# Camp Area 8 - 20 Acre site

50 % canopy loss in 7 years


Ongoing oak mortality, likely caused by goldspotted oak borer, located near Palomar Mountain, San Diego County.

Forest Service 2022 estimates 1600 acres with mixed oak mortality

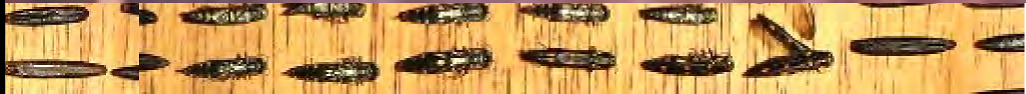
Photo ~30% tree mortality

2022 Aerial Detection Survey for Southern California (usda.gov)

# Fast Facts- Goldspotted Oak Borer

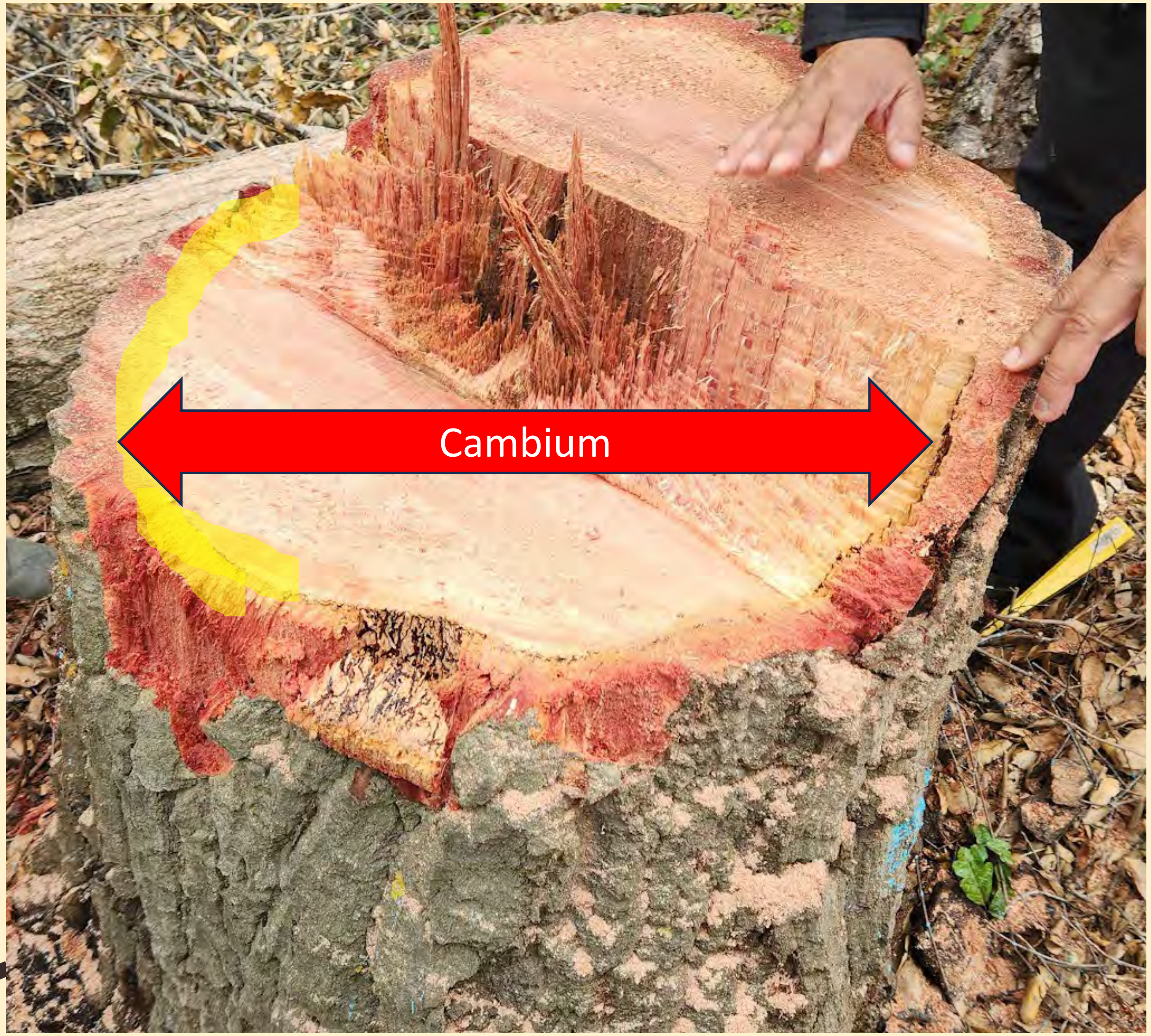
- Woodboring Buprestid jewel beetle
- Size of a grain of wild rice, with 6 gold spots
- Sourced to southeastern Arizona mountains[1,2]
- Red oak section of oaks (Quercus sect. Lobatae) hosts for feeding and reproduction[3]
    - Coast live oak – *Quercus agrifolia*
    - California black oak – *Q. kelloggii*
    - Canyon live oak – *Q. chrysolepis*


Photo Credit. Mike Lewis



1. Coleman, T. W., and S. J. Seybold. 2008. Previously unrecorded damage to oak, Quercus spp., in southern California by the goldspotted oak borer, Agrilus coxalis Waterhouse (Coleoptera: Buprestidae). Pan. Pac. Entomol. 84: 288Ð300
2. Coleman, T.W.; Seybold, S.J. Collection history and comparison of the interactions of the goldspotted oak borer, Agrilus auroguttatus Schaeffer (Coleoptera: Buprestidae), with host oaks in Southern California and Southeastern Arizona, U.S.A. Coleopts. Bull. 2011, 65, 93–108.
3. Venette, Robert C.; Coleman, Tom W.; Seybold, Steven J. 2015. Assessing the risks posed by goldspotted oak borer to California and beyond. In: Standiford, Richard B.; Purcell, Kathryn L., tech. cords. Proceedings of the seventh California oak symposium: managing oak woodlands in a dynamic world. Gen. Tech. Rep. PSW-GTR-251. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 317-329.

# How does GSOB Kill?

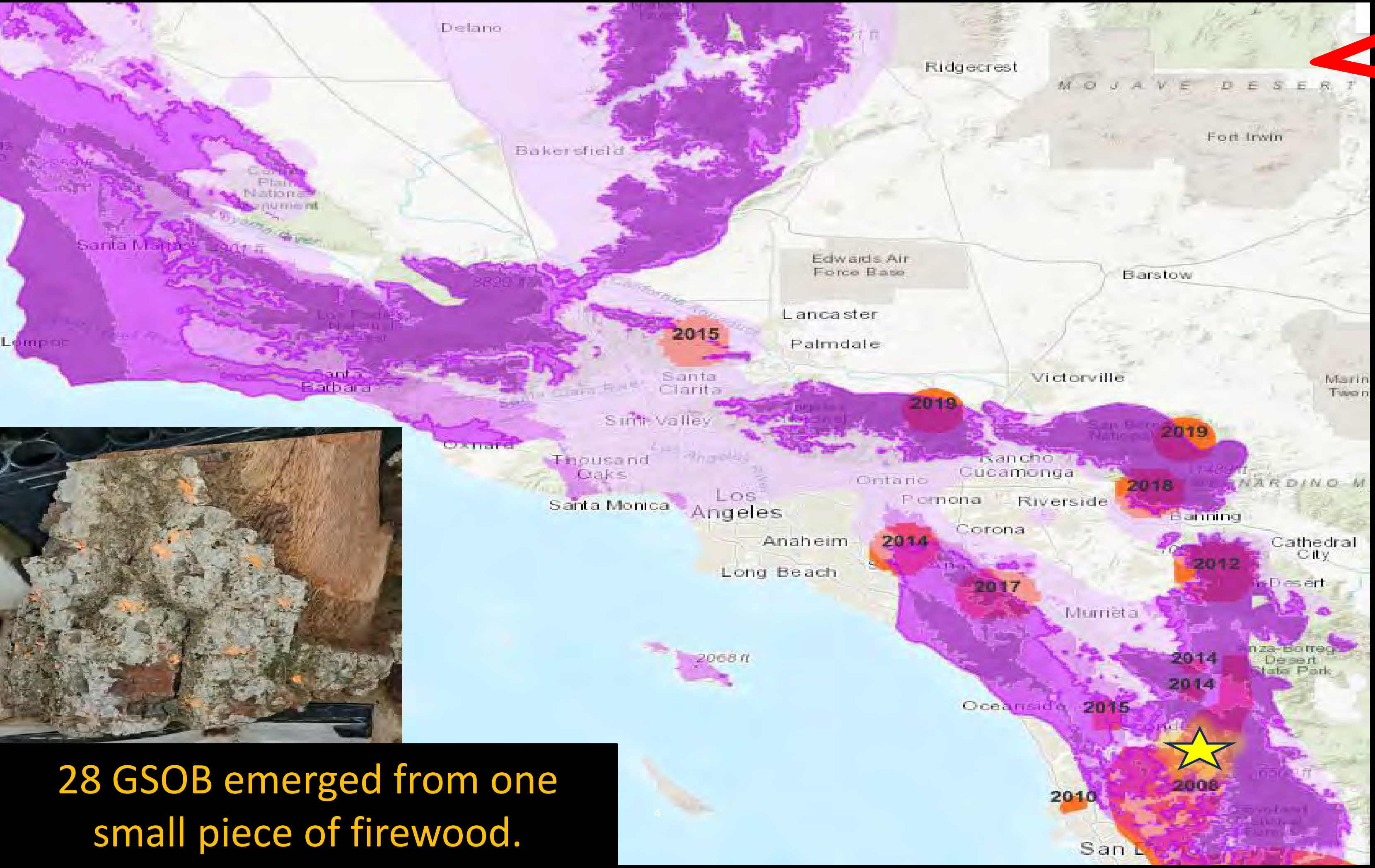



Larva eat the active growing region of the tree, which destroys the tree's vascular system

# Current and Potential Range

**GSOB** has killed ~80,000 oak trees throughout southern California and will continue to spread north into Oregon






28 GSOB emerged from one small piece of firewood.

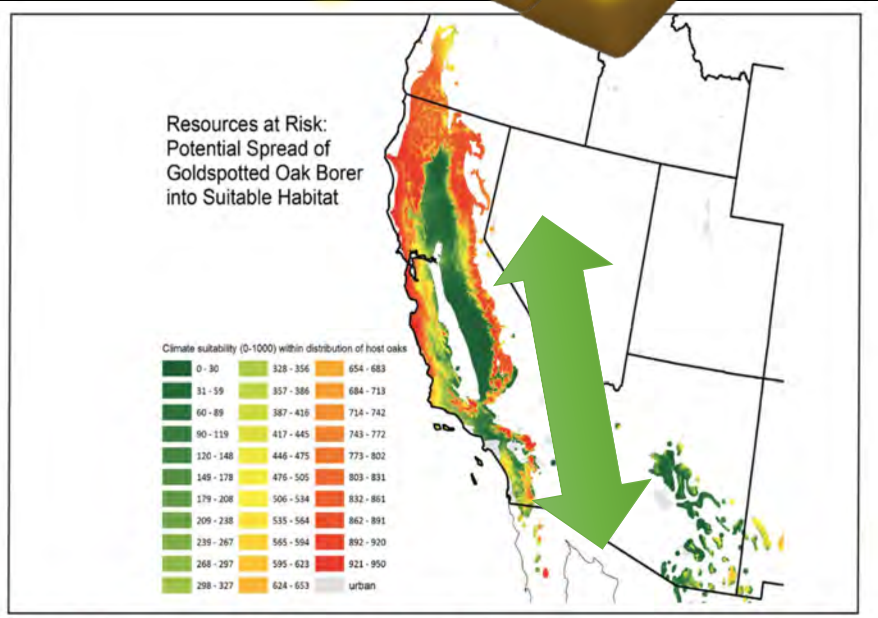
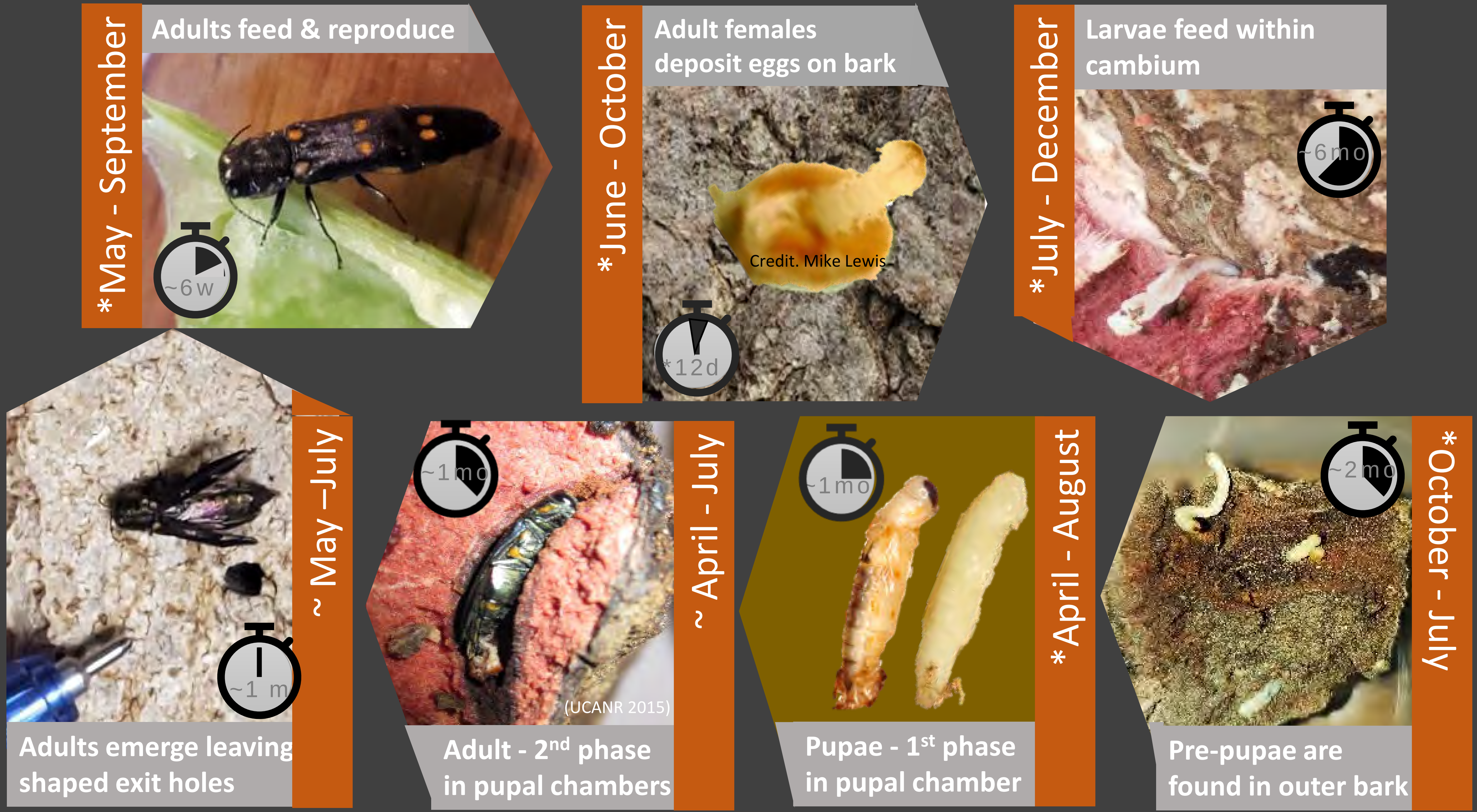



*Figure 3. Potential range of goldspotted oak borer in Arizona, California, New Mexico, Oregon, and Baja California Norte, Mexico based on host distributions and climatic suitability. On the map, areas with hosts are colored, and climatically suitable areas within the distribution of hosts appear as shades of yellow (moderately suitable), orange, and red (highly suitable).*

1. Tamm, J., 2023, Mortality estimate, and cost based off an estimate made in 2017 by Megan Jennings, San Diego State University, Personal email communications 2023
2. Map on Right: Venette, Robert C.; Coleman, Tom W.; Seybold, Steven J. 2015. Assessing the risks posed by goldspotted oak borer to California and beyond. In: Standiford, Richard B.; Purcell, Kathryn L., tech. cords. Proceedings of the seventh California Oak Symposium: Managing Oak Woodlands in a Dynamic World. Gen. Tech. Rep. PSW-GTR-251. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 317-329.
3. Map on left: https://ucanr.edu/sites/gsobinfo/Diagnosis_and_Management/GSOB_Management_StoryMap/

# GSOB ANNUAL LIFECYCLE

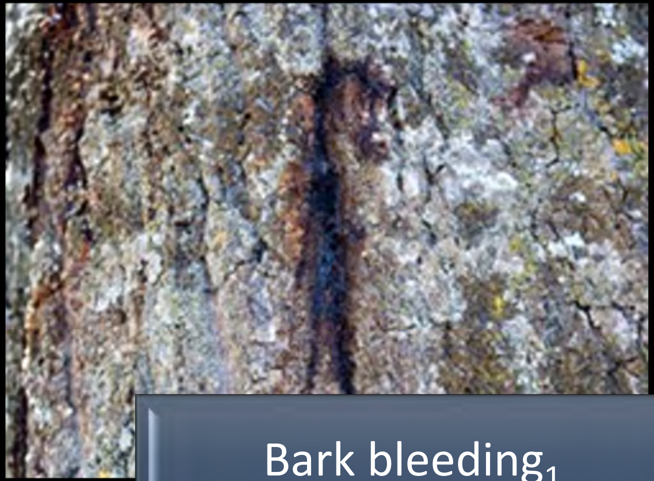



[8] * Coleman, T.W.; Jones, M.I.; Smith, S.L.; Venette, R.C.; Flint, M.L.; Seybold, S.J. 2015. Goldspotted oak borer, *Agrilus auroguttatus*. USDA Forest Service, Forest Insect & Disease Leaflet No. 183, 16 p.

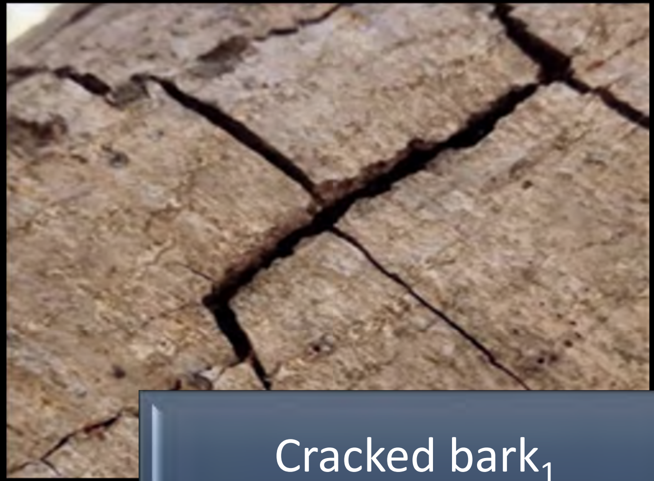
~ Denotes estimate from Tamm unpublished field, lab observations, or research-based estimates

D= days, W= Weeks, Mo= Months

# Symptoms of GSOB Tree Injury

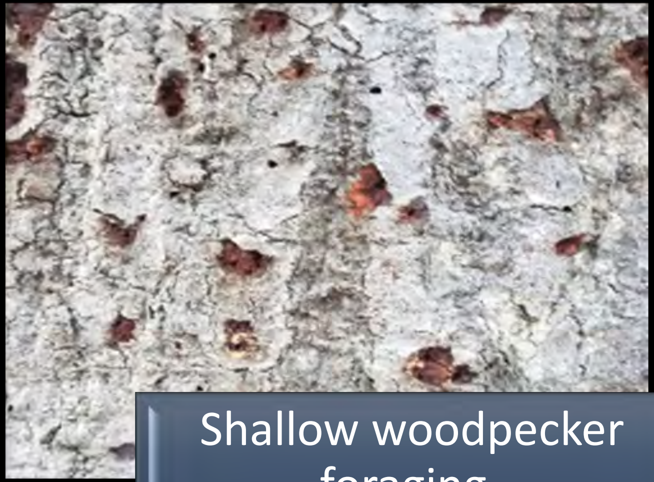


Bark bleeding[1]

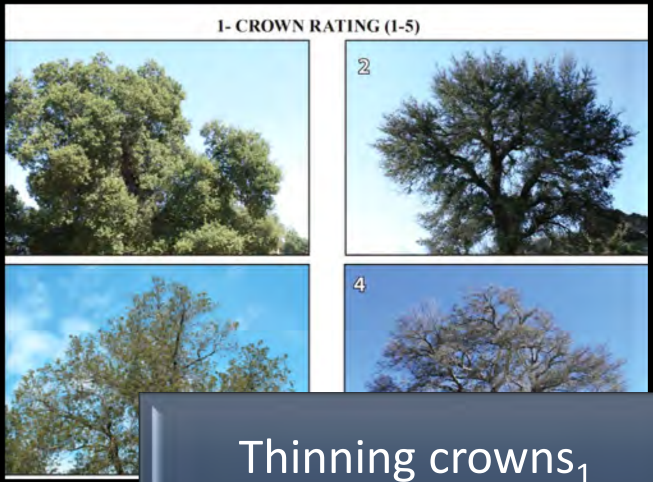


Cracked bark[1]


D-Shaped exit holes[1]



Shallow woodpecker foraging[1]




Thinning crowns[1]

Tree mortality[1]

[1] Hishinuma, S., T. W. Coleman, M.L. Flint, and S. J. Seybold. 2011. Goldspotted oak borer: Field identification guide, University of California Agriculture and Natural Resources, Statewide Integrated Pest Management Program, 6 pp., January 13, 2011., http://www.ipm.ucdavis.edu/PDF/MISC/GSOB_field-identification-guide.pdf

# Cultural Burning

Historical use land management tool which facilitated optimal harvest indirectly through obligatory cultural practices [1,5,7]

Technically is the original prescribed fire

Reduces insect damage and activity before and during harvest [1,2,5]

Ash and smoke were historically used to kill insects [2,3,4]

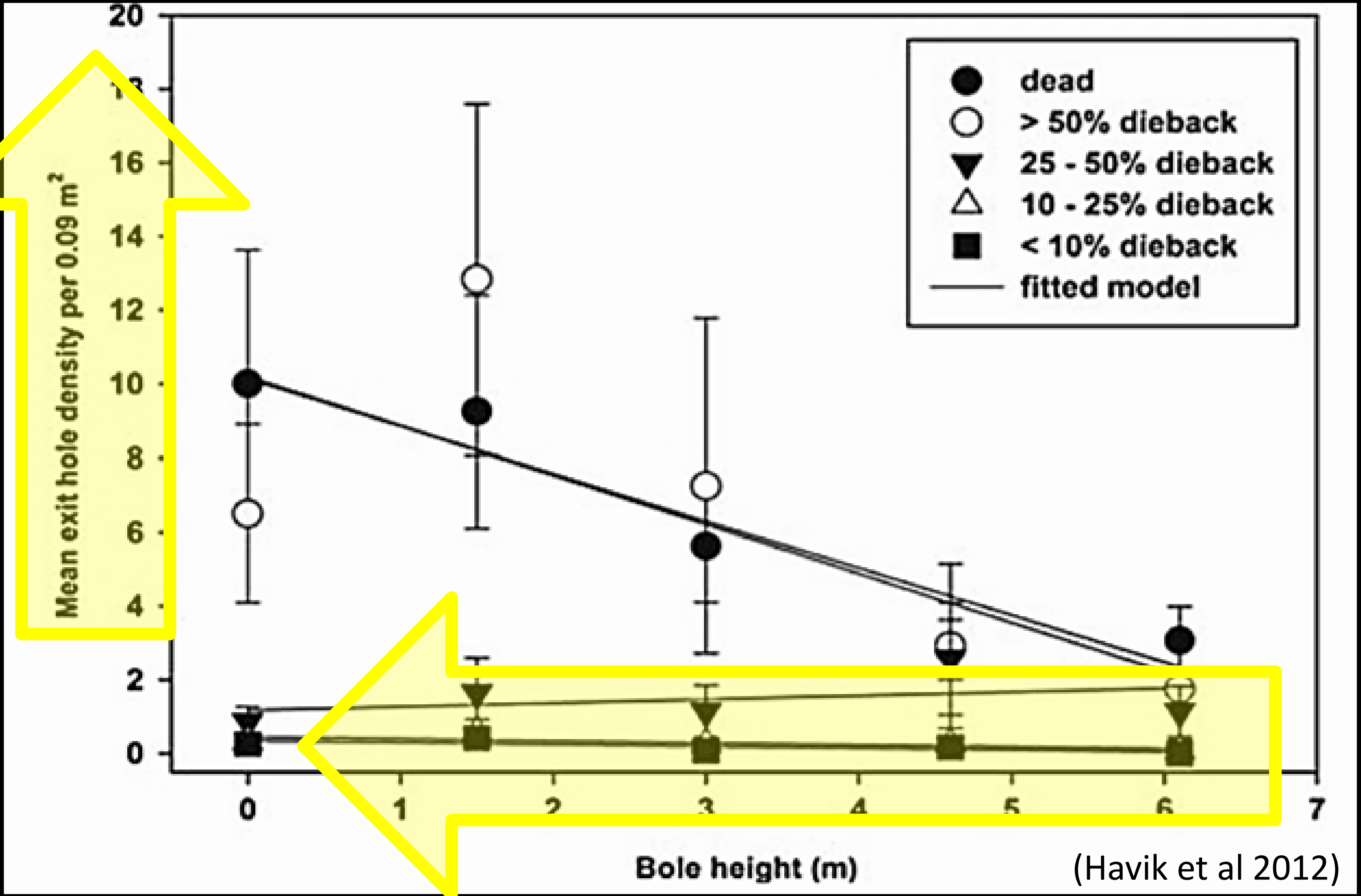
Resulted in severe punishment by early Spanish and colonial government [1,5,6]


1. Anderson, K. (2005). Tending the wild Native American knowledge and the management of California's natural resources. Berkeley: University of California Press.
2. Hakbijl, T. (2002) The Traditional, Historical and Prehistoric Use of 2. Ashes as an Insecticide, with an Experimental Study on the Insecticidal Efficacy of Washed Ash, Environmental Archaeology, 7:1, 13-22, DOI: 10.1179/env.2002.7.1.13
3. MAJUMDER (1959), S. K., et al. "Insecticidal Effects of Activated Charcoal and Clays." Nature, vol. 184(Suppl 15), pp. 1165–1166. EBSCOhost
4. KRISHNAKUMARI, M. K., and S. K. MAJUMDER(1962). "Modes of Insecticidal Action of Active Carbon and Clay on Tribolium Castaneum (Hbst.)." Nature, vol. 193, pp. 1310–1311.
5. Rodriguez, S. (2022), Keynote speaker at SoCal Interagency Wildland Fire Training Cadre S130/190 class at Cuyamaca Rancho State Park
6. Lightfoot,K., Cuthrell, R., Stripln, C., Hylkema, M.,(2013). Anthropogenic Burning on the Central California Coast in Late Holocene and Early Historical Times: Findings, Implications, and Future Directions. California Archaeology. 5. 371-390. 10.1179/1947461X13Z.00000000020.
7. Bean, Lowell John and Florence C. Shipek (1978). *"Luiseno", Handbook of North American Indians, Volume 8*. Smithsonian Institution, Washington, D.C..

# D-Shaped Exit Holes

Primarily found on the lower 6 meters of the tree trunk and large branches [1]

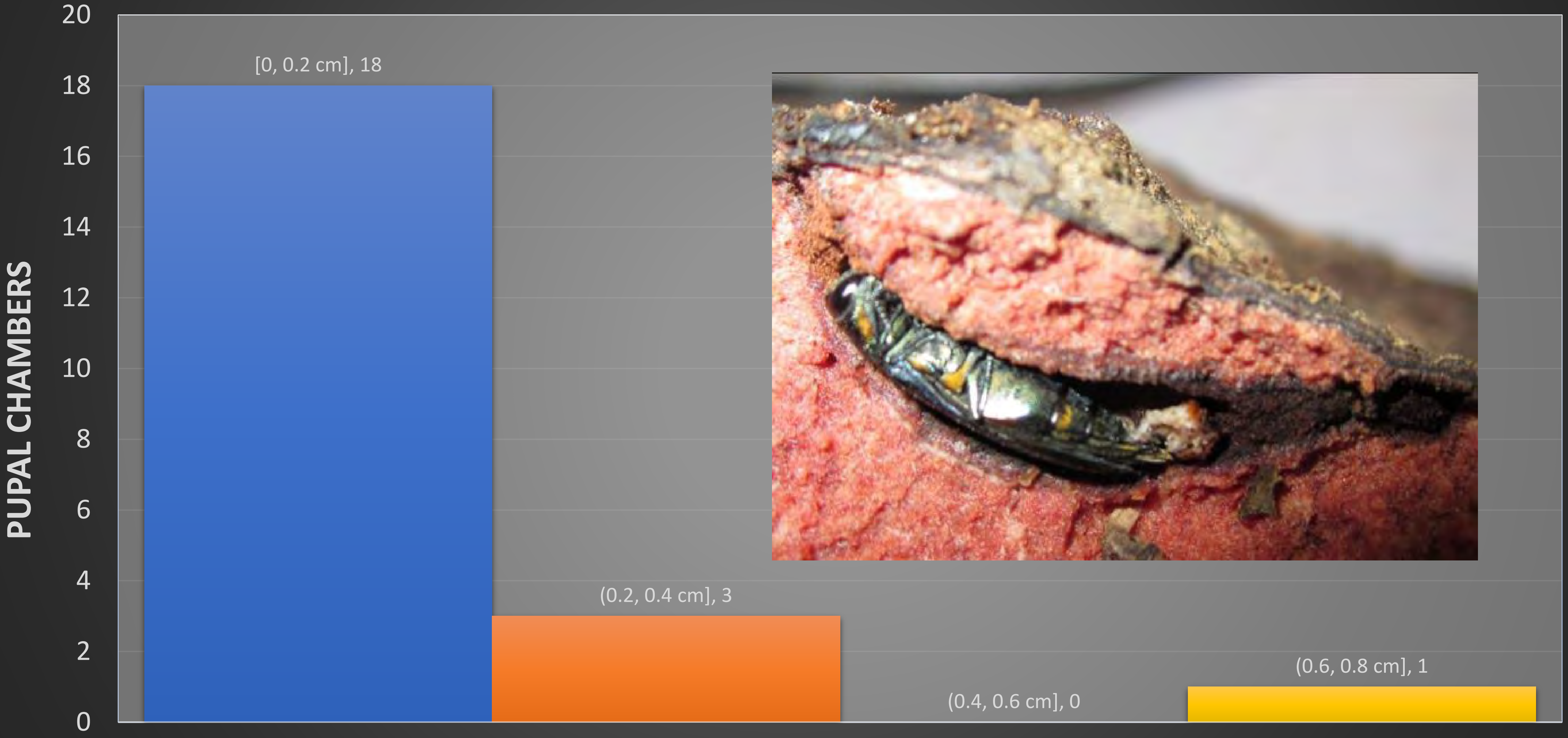
Exit holes usually represent successful adult emergence




(Havik et al 2012)

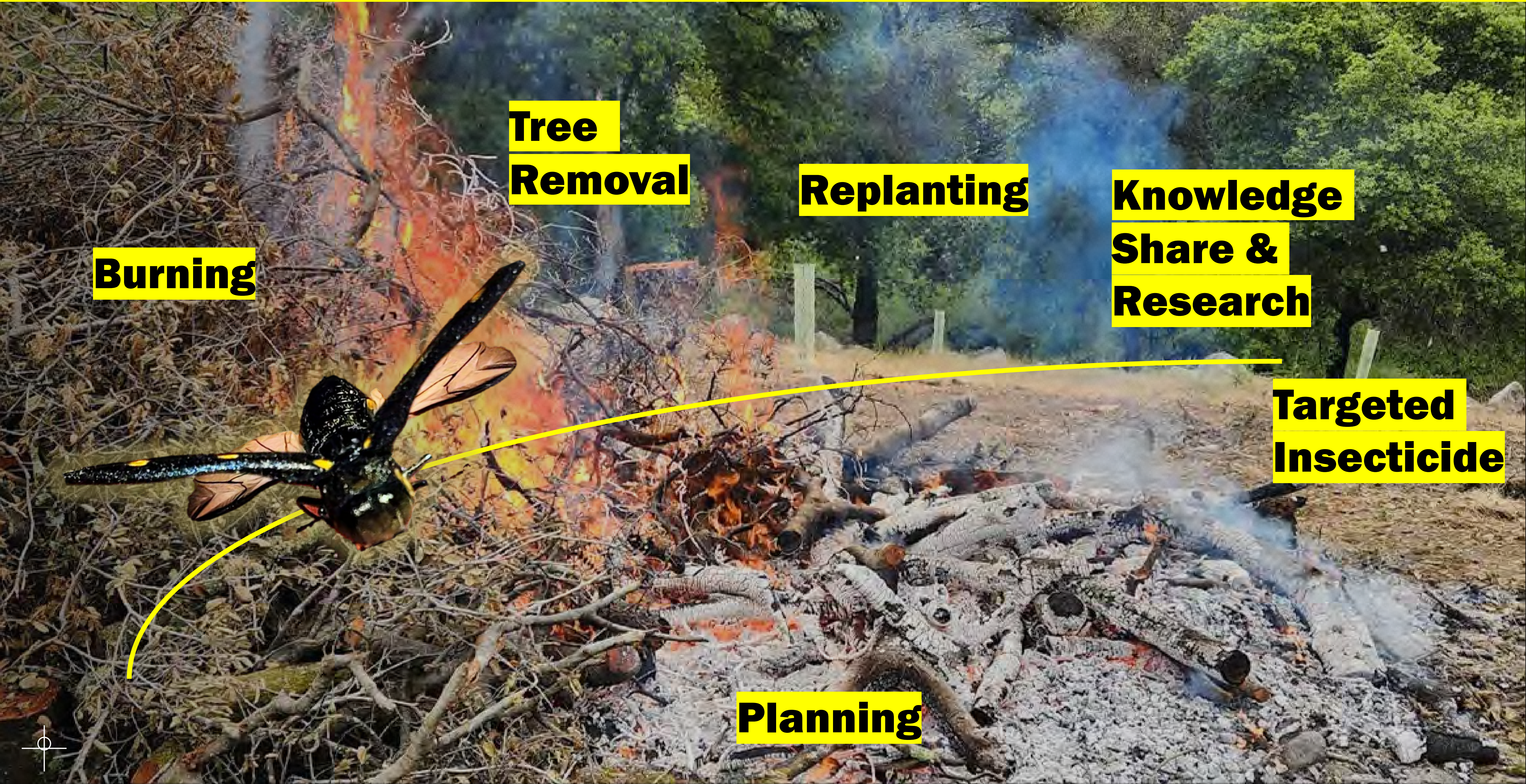
1. Haavik, L.J.; Coleman, T.W.; Flint, M.L.; Venette, R.C.; Seybold, S.J. 2013. Agrilus auroguttatus (Coleoptera: Buprestidae) seasonal development within Quercus agrifolia (Fagales: Fagaceae) in southern California. Annals of the Entomological Society of America. 106(2): 189-197

# Pupal Chamber Distance from Outer Bark
# Quercus agrifolia




1. Tamm, J., Lanphere., 2019 Unpublished undergraduate research paper. Pupation cell location of the Gold Spotted Oak Borer Beetle for Management Decisions, California Baptist University.

# GSOB Landscape Level Mitigation

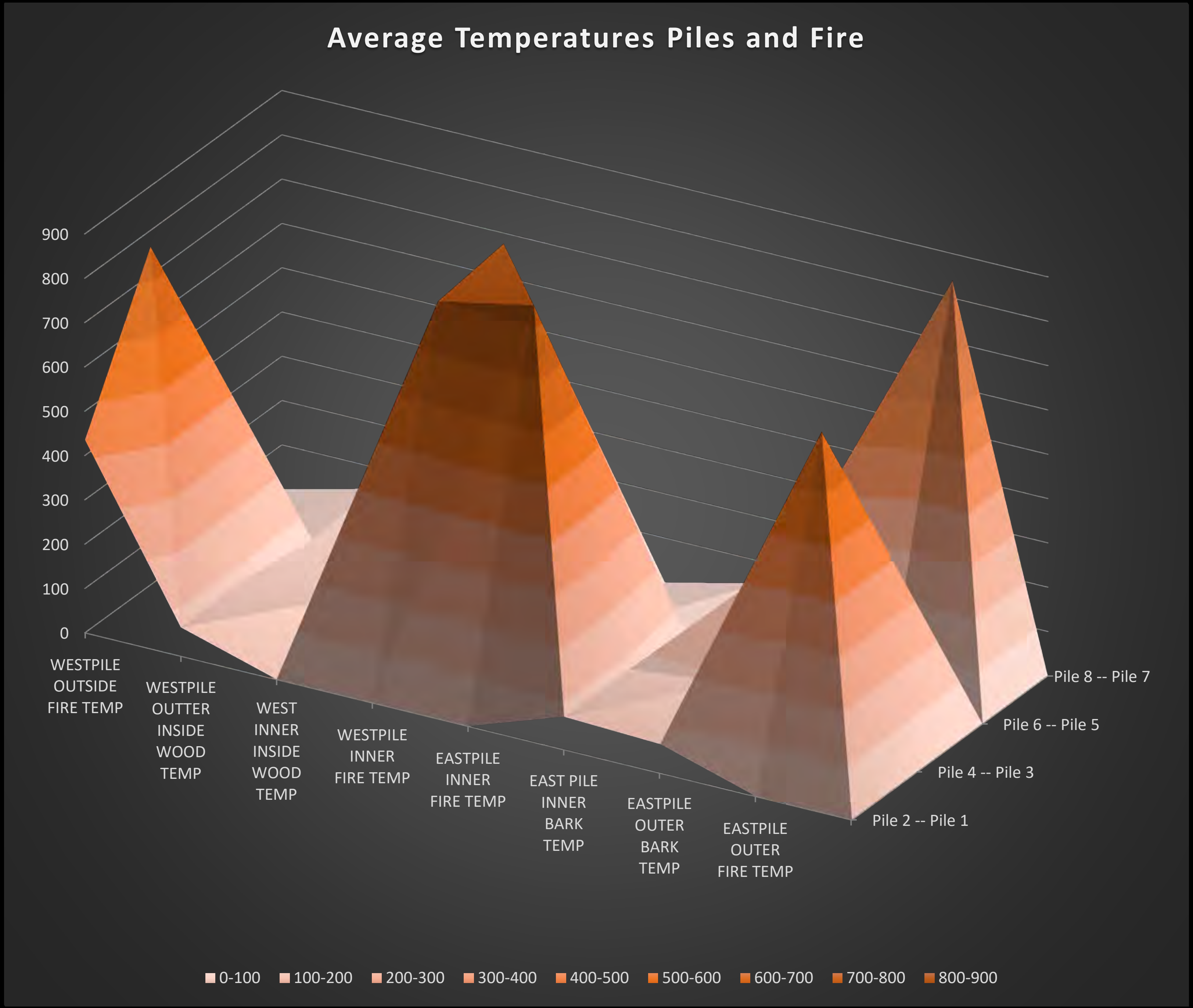


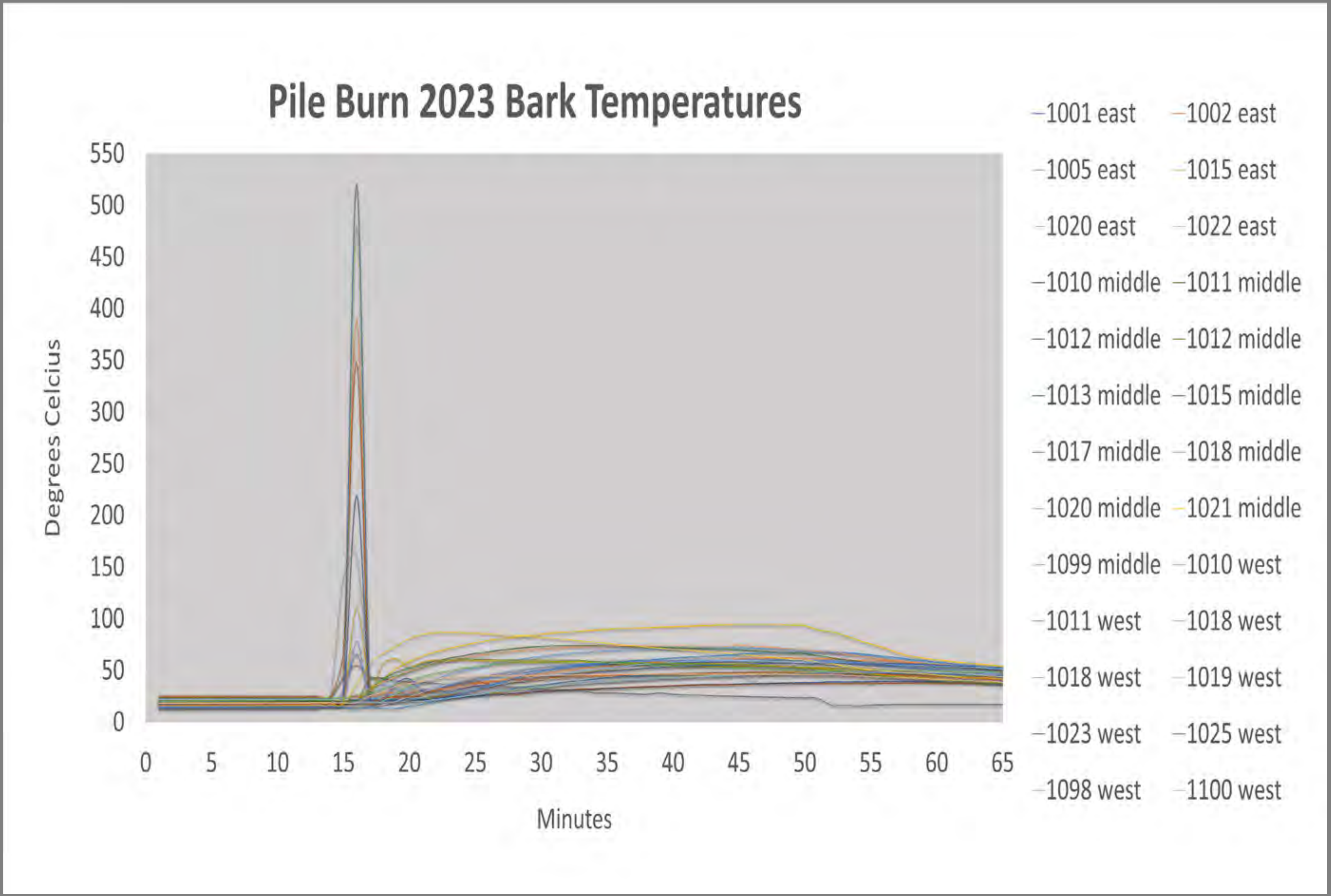
# OBJECTIVES

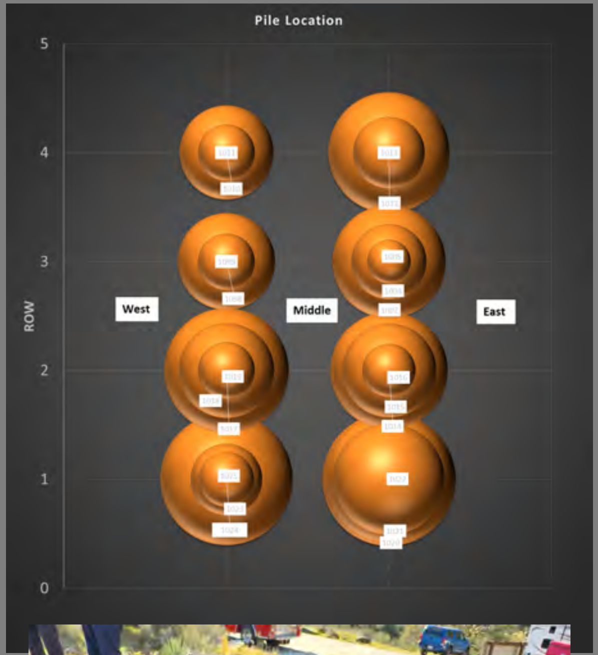
1) Review Native American Traditional Ecological Knowledge on Cultural Burning
2) Reduce GSOB population and wildfire risk
3) Identify landscape-level management practice
4) Identify potential parasitoids for biological control

# Pile Burn Experiment 2-20-2023

# Fire Temps Peaked at 800 °C





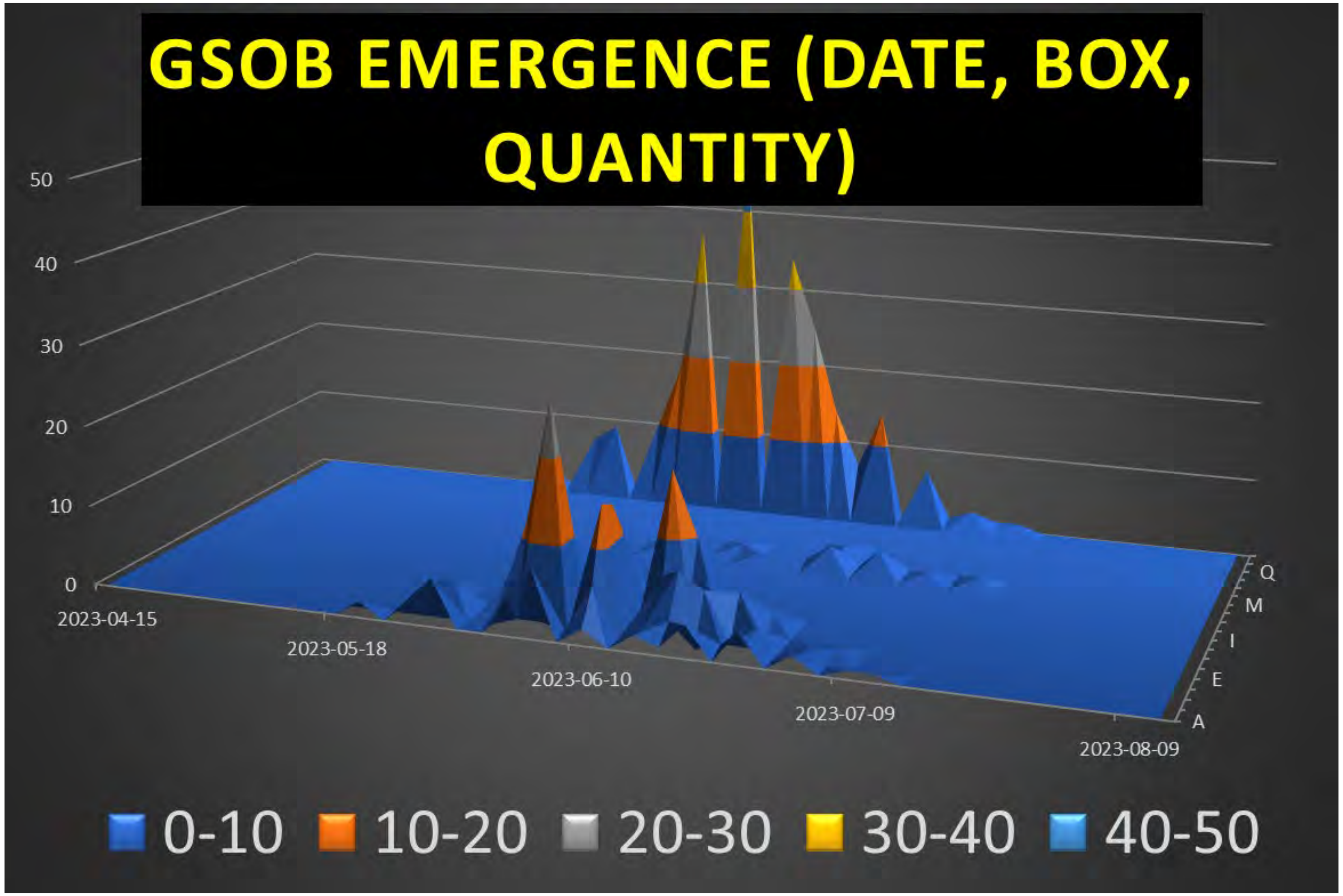




8 minutes of direct flame - 20 minutes of smoldering

# Preliminary examination


# Placed infested wood in crates

# Collected GSOB





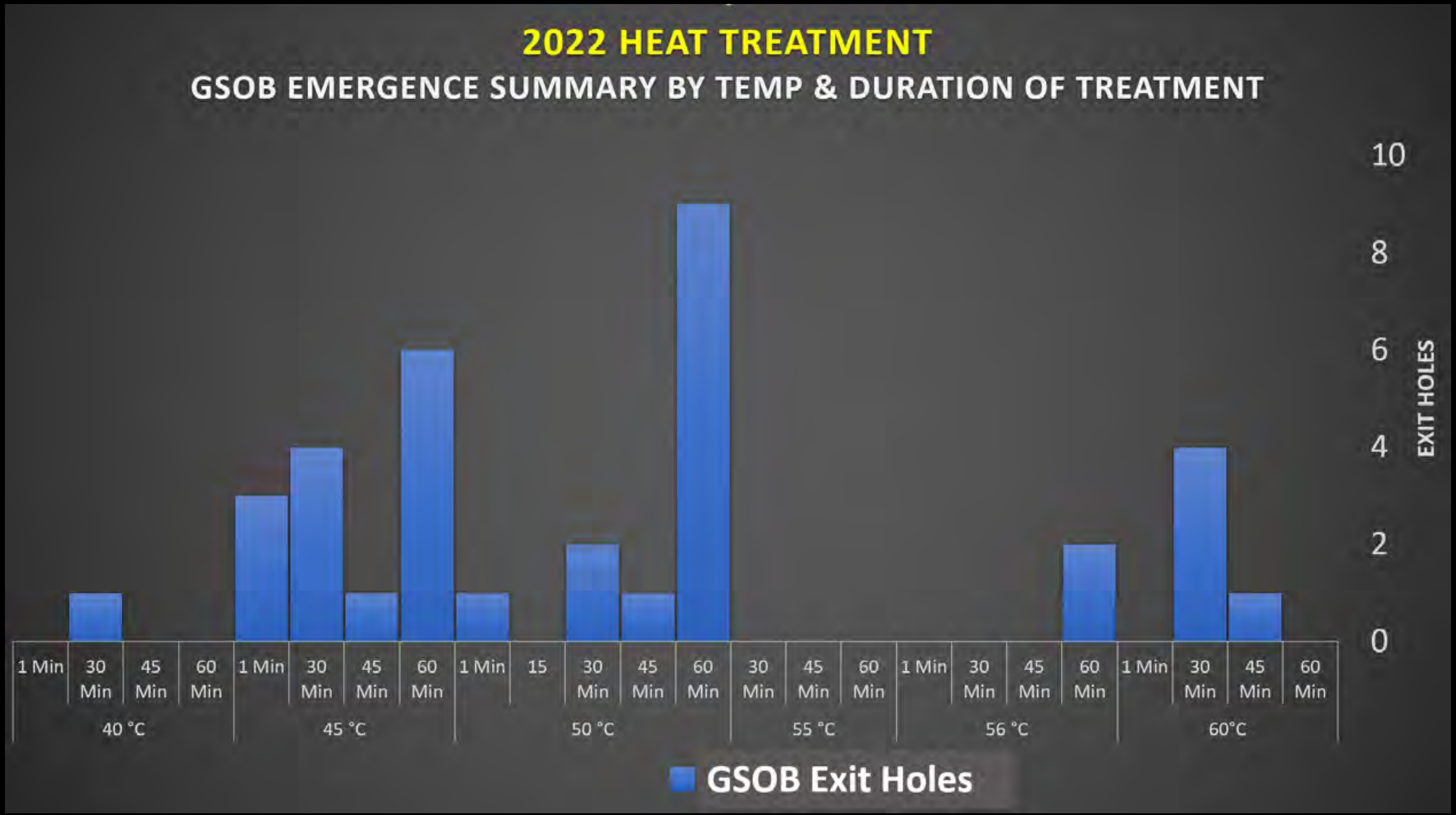
**Emergence from 7 untreated infested rounds = 216**

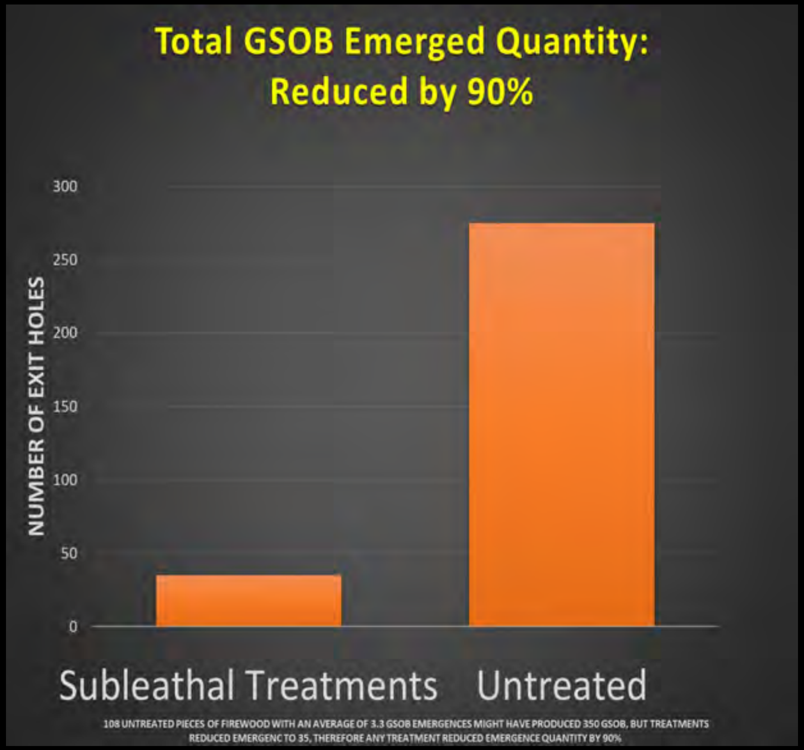
**Emergence from 24 burned rounds = 15**

**98% Reduction**

# Heat Treatment Experiment 2022

A heavily infested tree was identified and cut down and processed by the La Jolla Indian Forestry Crew. The firewood was inspected, and a portion was heat treated and then placed into containers to monitor emergence.



# Heat Treatment Experiment 2023



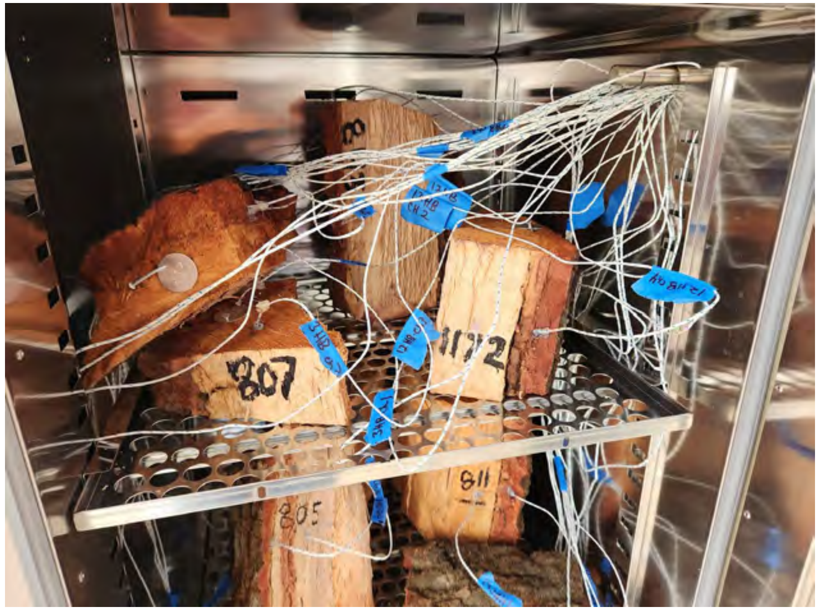




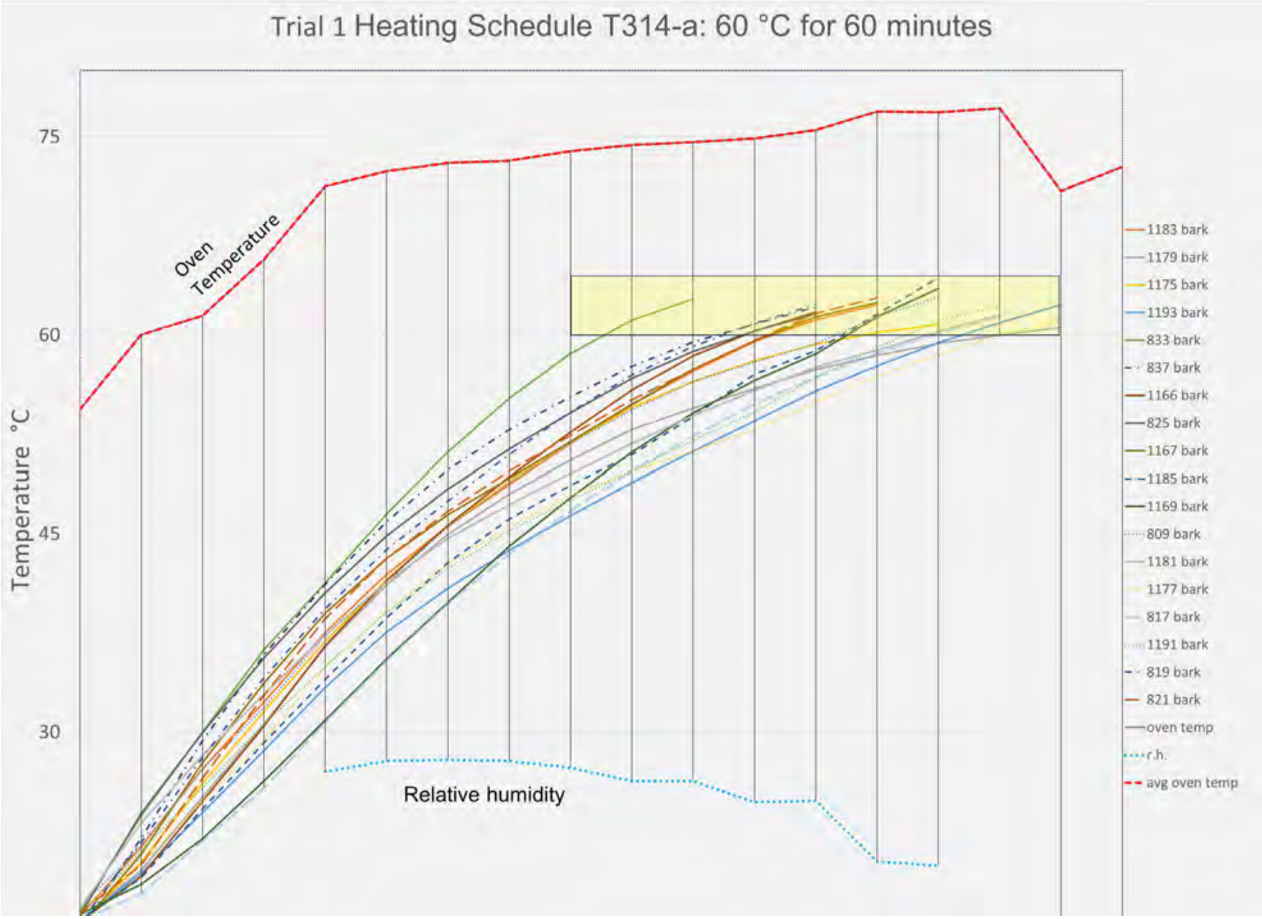

- Tested 71.1 °C for 75 min at oven temp of 85 °C (T314-c)
- Tested 60 °C for 60 min at oven temp of 75 °C (T314-a)

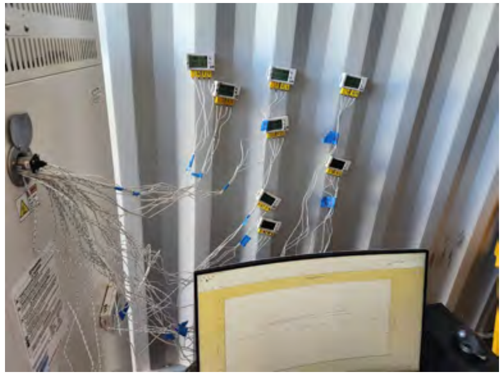
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment.pdf

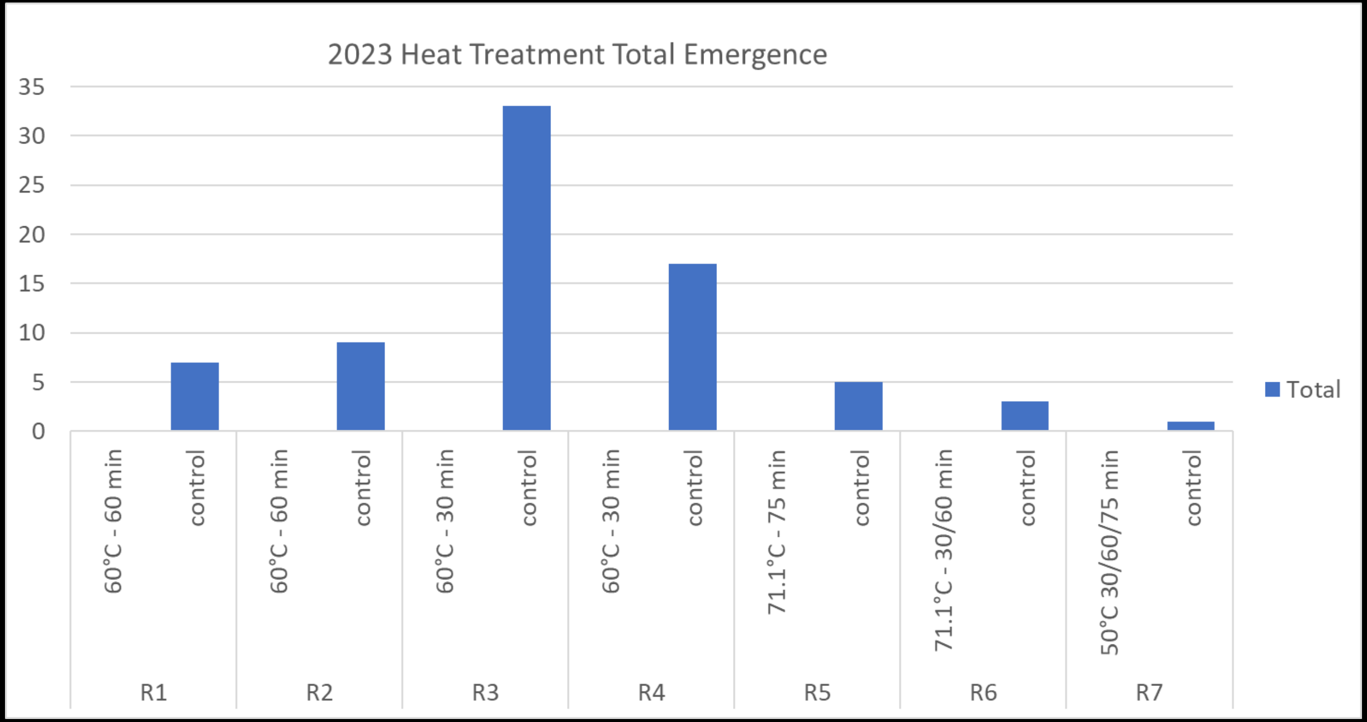
# Heat Treatment Trial 1 Summary

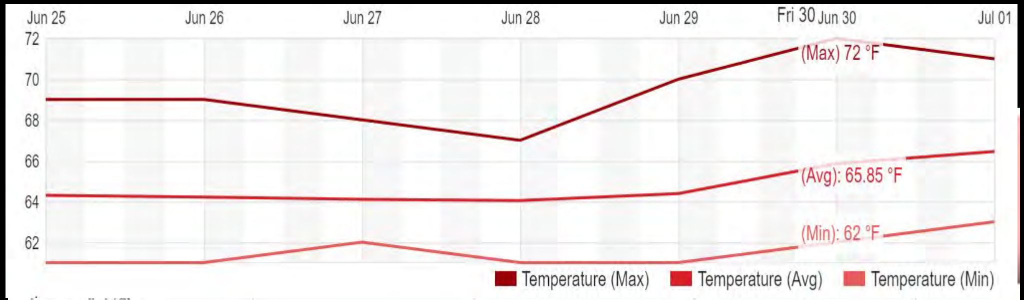


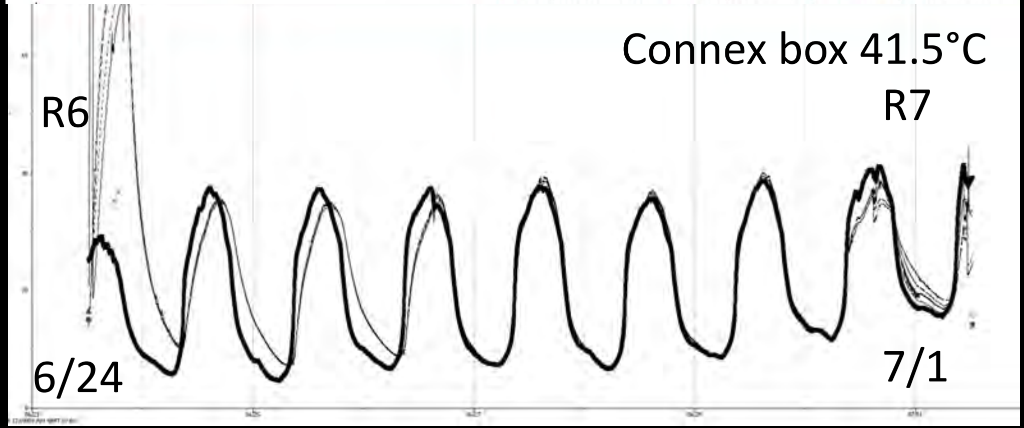

- Bark and core temps recorded
- Bark heated faster than the core in 8 samples
- Range heating time: 325 to 539 minutes
- Range heating times at target time: 60 to 67 minutes
- Range volume of sample:  2000 to 6000 cubic cm
- Range in moisture content: 16 to 95%
- DKN912C - Force convection oven 535L/EA 220V 18A
- Oven temp set to 80 °C (Avg heating temp 74 °C



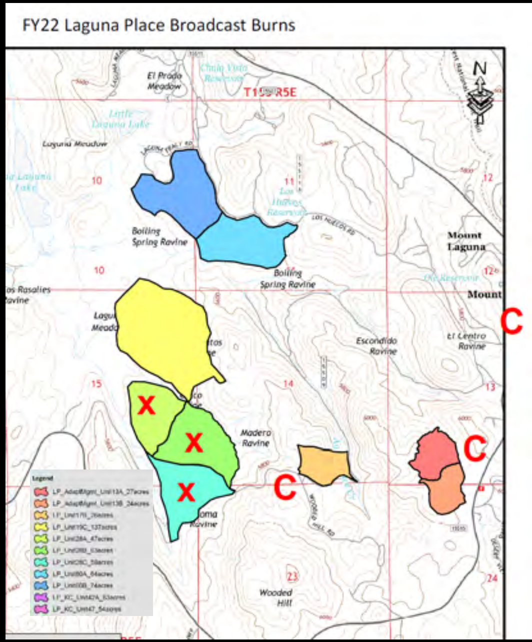



- Sample size was larger in 2023; As expected, there was no emergence in treatments 60°C for 60 minutes and greater, but there was no emergence in lesser treatments which were obtained in 2022
- Emergence rates in untreated firewood were much lower than in 2022 (275 GSOB compared to 74)
- Control emergence likely declined in R6 and R7 because firewood was left in the Conex box during the heat wave due to injury as temperatures exceeded 40°C during the day, likely contributing to beetle mortality

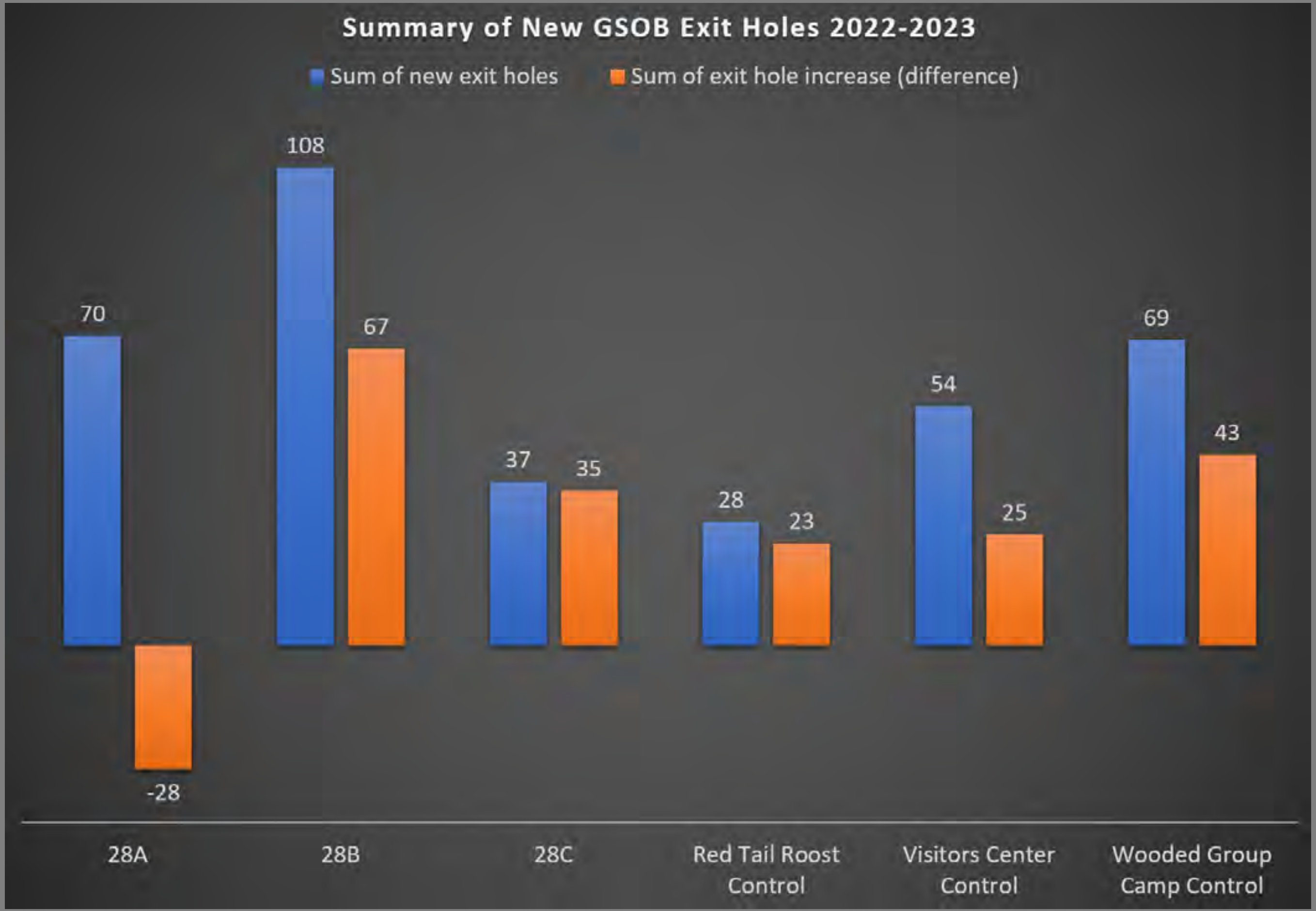
# Prescribed Fire Field Study




In Spring of 2022 Forest Service Conducted Prescribed burns

1. Surveyed plots before and after prescribed fire finished surveys Surveyed small, medium, large DBH black oak trees
2. 3 Control plots, 3 prescribed burn plots
3. Marked 2022 exit holes in orange by 4-9-23
4. Marked 2023 exit holes in white/pink-red by 5-3-23

# Mt. Laguna Rx Fire Preliminary Results

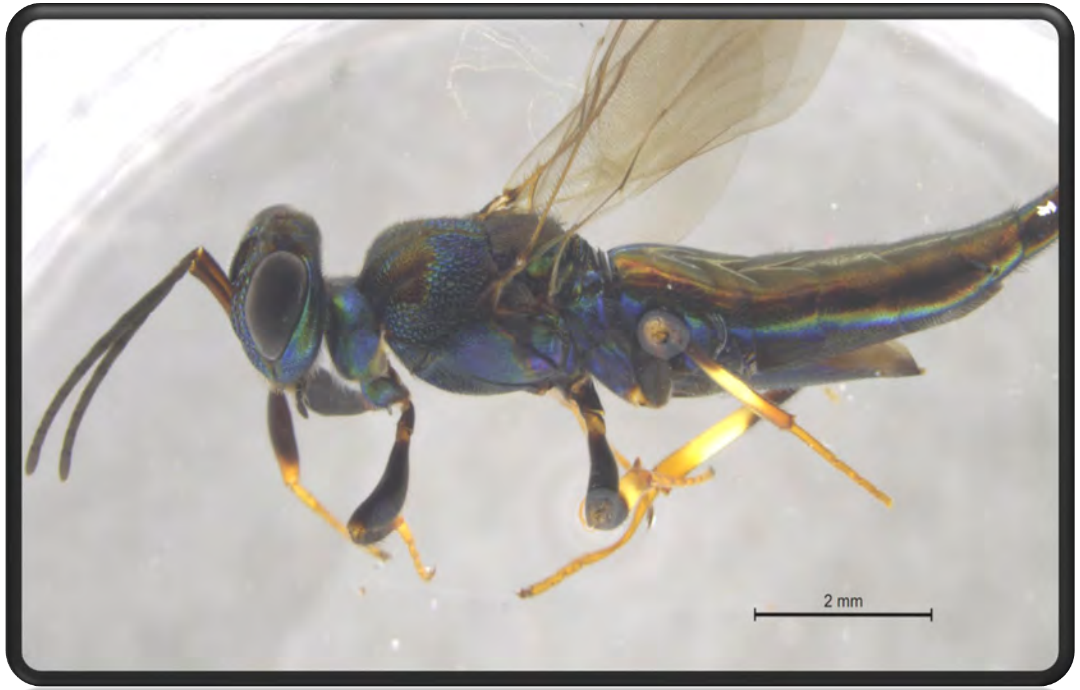



Potential problems with exit hole count findings

1. Could not find all holes marked in 2022
2. Orange lumber crayons faded, and some exit holes flaked off
3. Human Error?

# Potential Parasitoids

Identified by Gary Gibson from a photo as *Balcha indica*




parasitoid of emerald ash borer <4% (Taylor et al. 2011)

Possibly using GSOB as a host ~ 3% parasitism (Tamm 2022 unpublished)

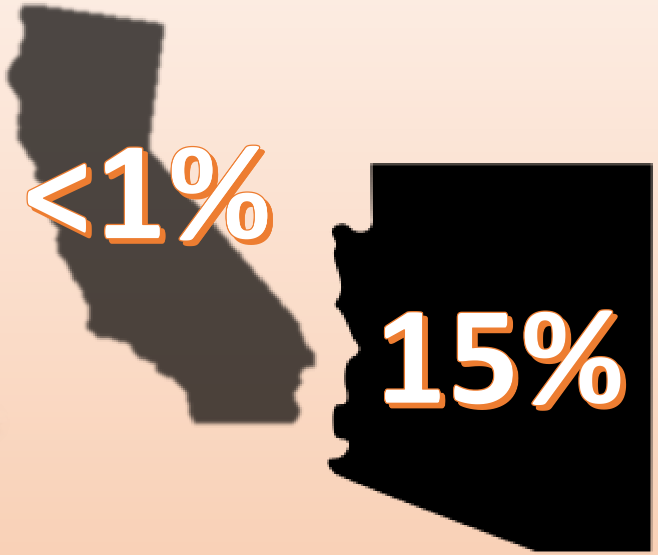
Ryan Campos and Krissy Dominguez in Heraty Lab confirming the identity

Solitary ectoparasitoid of larva, pupae, thelytokous parthenogenesis [1]

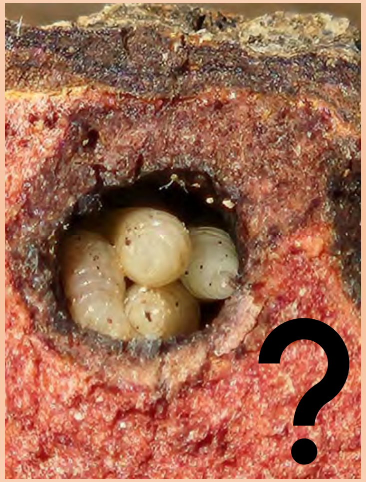
Collected in the La Jolla Indian Reservation after ovipositing, and from reared logs

1. J. J. Duan, R. W. Fuester, J. Wildonger, P. B. Taylor, S. Barth, S. E. Spichiger "Parasitoids Attacking the Emerald Ash Borer (Coleoptera: Buprestidae) in Western Pennsylvania," Florida Entomologist, 92(4), 588-592, (1 December 2009)

# Eupelmidae - *Calosota elongata*




- Gregarious & ectoparasitic
- Native to Arizona
- Collected from GSOB pupal chambers in California
- Ryan Campos in Heraty Lab, confirming the identity





1. 1% parasitism Pauma Valley 2023 (Tamm unpublished 2022
2. 1% Pine Creek Trailhead CNF (Haavik et al. 2012).
3. Taylor, P. B., Duan, J. J., Fuester, R. W., Hoddle, M., & Van Driesche, R. (2012). Parasitoid guilds of *agrilus* woodborers (Coleoptera: Buprestidae): Their diversity and potential for use in biological control. *Psyche: A Journal of Entomology*, *2012*, 1–10. https://doi.org/10.1155/2012/813929

# Many Thanks to:

La Jolla Band of Luiseno Indians: Tribal Council, Fire Department, Environmental Department, Public Works, and Natural Resources Department, with extra appreciation to Wesley Ruise Jr., Bill Nelson, Norma Contreras, and Rob Roy

UCR: Mark Hoddle, Thomas Scott, Thomas Perring, Tim Paine, John Heraty, Krissy Dominguez, Ryan Campos

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State Parks: Samantha Birdsong, Mike Puzzo

Condor Visual Media

Ryan Kelly

And my family and friends and everyone else!

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Squaxin Island Tribe

COBELL SCHOLARSHIP

LA JOLLA BAND LUISEÑO INDIANS EST. 1875

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

CALIFORNIA DEPARTMENT OF FORESTRY & FIRE PROTECTION CAL FIRE SINCE 1885

CALIFORNIA CLIMATE INVESTMENTS Cap and Trade Dollars at Work

AMERICAN INDIAN SCIENCE AND ENGINEERING SOCIETY

UC RIVERSIDE UNIVERSITY OF CALIFORNIA

CBU

UC Davis - Inter-Institutional Network for Food, Agriculture, and Sustainability (INFAS)

# Questions?

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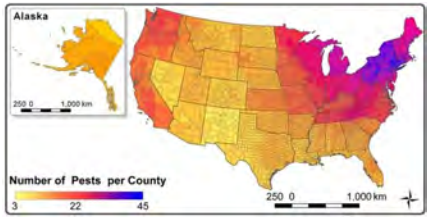
# Additional Resources

Spread the News
Not the Bug
www.GSOB.org

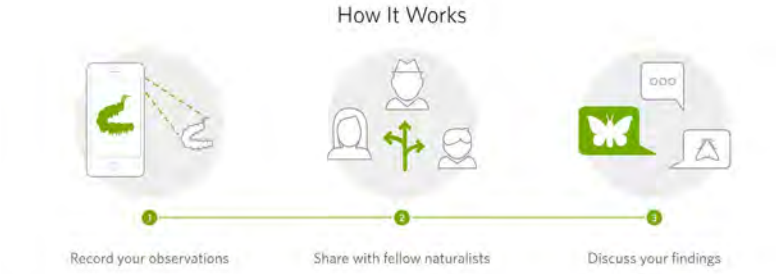
DON'T MOVE FIREWOOD.org

UC RIVERSIDE | Center for Invasive Species Research

CENTER FOR INVASIVE SPECIES PREVENTION




iNaturalist

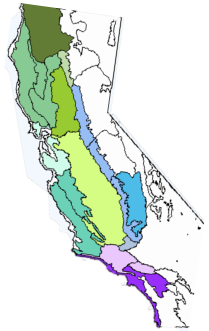


# What additional Species are at Risk?

**_Quercus wislizeni_**
INTERIOR OAK[1,5,6]

**_Quercus douglasii_**
BLUE OAK[2,5,6]


**_Quercus lobata_**
VALLEY OAK [3,4,5]



**_Quercus parvula_**
SHREVE OAK [4,6]

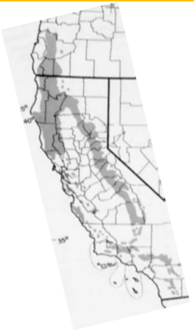
**_Quercus suber_**
CORK OAK [5]


Urban forest with a Mediterranean climate Riverside to Bay Area

**_Quercus kelloggii_**
BLACK OAK [4,5,6]

**_Quercus agrifolia_**
BLACK OAK [4,5,6]

**_Quercus chrysolepis_**
CANYON LIVE OAK [2,4,6]

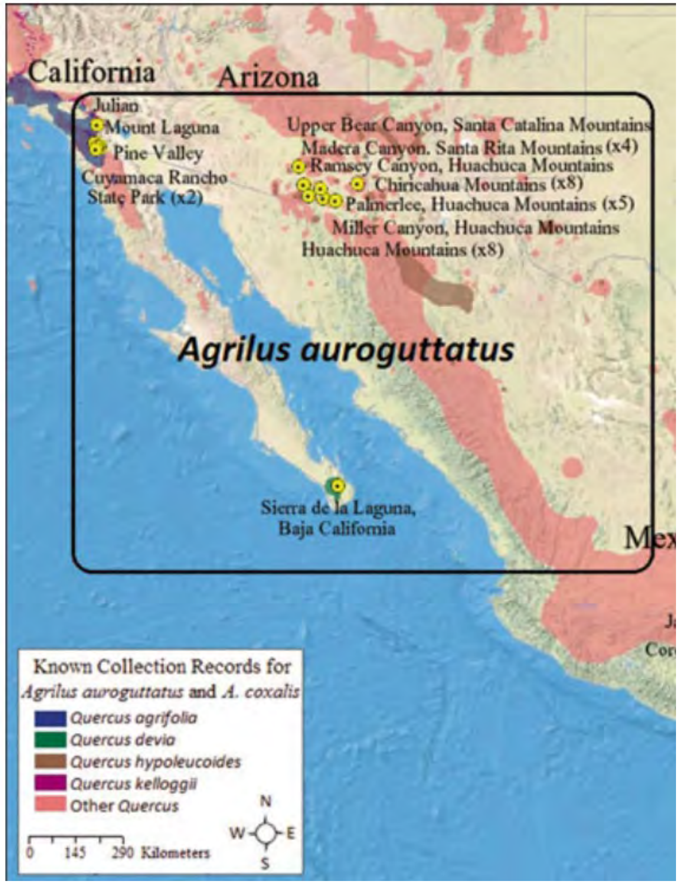


**Other Oaks**
SECTION LOBATAE, PROTOBALANUS, CERRIS (purple, tan, green)


1. Thompson, Robert S.; Anderson, Katherine H.; Bartlein, Patrick J. 1999. Digital representations of tree species range maps from "Atlas of United States trees" by Elbert L. Little, Jr. (and other publications), [Online]. In: Atlas of relations between climatic parameters and distributions of important trees and shrubs in North America--GIS files of tree species range maps. U.S. Geological Survey Professional Paper 1650 A&B. Reston, VA: U.S. Geological Survey, Geology and Environmental Change Science Center, Earth Surface Processes (Producer). Available: http://esp.cr.usgs.gov/data/atlas/little/ [2011, June 8]. [82831]
2. Griffin, James R., and William B. Critchfield. 1972. (Reprinted with supplement, 1976). The distribution of forest trees in California. USDA Forest Service, Research Paper PSW-82. Pacific Southwest Forest and Range Experiment Station, Berkeley, CA. 118 p (https://www.srs.fs.usda.gov/pubs/misc/ag_654/volume_2/quercus/douglasii.htm)
3. Citation for this treatment: Thomas J. Rosatti & John M. Tucker 2014, *Quercus lobata*, in Jepson Flora Project (eds.) *Jepson eFlora*, Revision 2, https://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=40663, accessed on August 29, 2023.
4 Coleman, Tom. W; Seybold, Steven.J. 2016. Goldspotted oak borer in California: invasion history, biology, impact, management, and implications for Mediterranean forests worldwide. In: Paine, T.D.; Lieutier, F., eds. Insects and Diseases of Mediterranean Forest Systems. Cham, Switzerland: Springer International Publishing: 663-697. https://doi.org/10.1007/978-3-319-24744-1_22
5. Venette, Robert C.; Coleman, Tom W.; Seybold, Steven J. 2015. Assessing the risks posed by goldspotted oak borer to California and beyond. In: Standiford, Richard B.; Purcell, Kathryn L., tech. cords. Proceedings of the seventh California oak symposium: Managing Oak Woodlands in a dynamic world. Gen. Tech. Rep. PSW-GTR-251. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 317-329.
6. Hauser DA, Keuter A, McVay JD, Hipp AL, Manos PS. The evolution and diversification of the red oaks of the California Floristic Province (Quercus section Lobatae, series Agrifoliae). Am J Bot. 2017 Oct;104(10):1581-1595. doi: 10.3732/ajb.1700291. PMID: 29885216

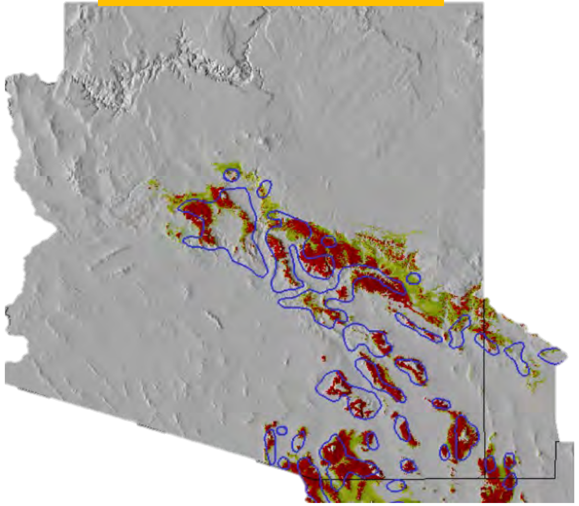
# Other Areas GSOB Can Originate From

## Historical GSOB Collection Records[1]




## *Quercus emoryi*

EMORY OAK[1,2]



## *Quercus hypoleucoides*

SILVERLEAF OAK[1,2]

1. Coleman, Tom. W; Seybold, Steven. J. 2016. Goldspotted oak borer in California: invasion history, biology, impact, management, and implications for Mediterranean forests worldwide. In: Paine, T.D.; Lieutier, F., eds. Insects and Diseases of Mediterranean Forest Systems. Cham, Switzerland: Springer International Publishing: 663-697. https://doi.org/10.1007/978-3-319-24744-1_22
2. Virginia Tech, Plant Species and Climate Profile Predictions for Emory oak, 2023 https://charcoal2.cnre.vt.edu/climate/species/speciesDist/Emory-oak/current.png
3. Virginia Tech dendrology for silverleaf oak, accessed 2023 https://dendro.cnre.vt.edu/dendrology/images/Quercus%20hypoleucoides/map.jpg

# Problem Agrilus Beetles



PURDUE EXTENSION

WB-01-W

America's Least Wanted Wood-Borers

Department of Entomology

OAK SPLENDOR BEETLE, *AGRILUS BIGUTTATUS* (FABRICIUS)

*Jeffrey D. Holland, K. R. Raje, J.T. Shukle, and V. R. Ferris, Entomologists*

This metallic wood-boring beetle (Family Buprestidae) primarily attacks oaks. Oak trees under stress are especially at risk. Oak trees in climatic conditions similar to the beetle's native range exist at many North American ports. Controlling this beetle will be very difficult if it becomes established because the larval stage causing damage is concealed within the tree as with other wood-borers.

**Distribution:** The native geographical range of this beetle includes parts of Asia, Africa and Europe.

**General Description:** The shiny green adults are slender, cylindrical insects with a length of 9 – 12 mm. On the interior edge of the posterior third of the elytra are two distinct white marks. Grubs are creamy white, legless, and upon maturity reach a length of 24 – 43 mm. The first thoracic segment is broader than the remaining body segments. The last abdominal segment bears two hornlike projections. Trees attacked by these beetle show symptoms such as dieback, growth of epicormic shoots, thinning of crown, meandering larval galleries filled with frass, D-shaped exit holes made by the emerging adults, and tree death.

**Biology:** The larvae within the genus *Agrilus* are cambium feeders or stem feeders. Feeding in the cambium results in meandering galleries beneath the bark. The adults emerge through D-shaped exit holes. Adults fly from May to July, and may fly several kilometers to find suitable host trees for the next generation. Adults feed on the foliage of oaks. Eggs are laid in clusters of

Systems database <www.boldsystems.org>. If a specimen of this species is suspected, DNA analysis could help to confirm the identification even if the material is of a life stage that cannot be identified with morphological identification techniques.

L - Adult *A. biguttatus (Photo credit: Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org.);*

R - Larva *A. biguttatus (Photo credit: Louis-Michel Nageleisen, Département de la Santé des Forêts, Bugwood.org.)*