Weaving knowledge, healing land: A community-based approach to resilience in the face of goldspotted oak borer and altered fire regimes

Joelene Tamm, La Jolla Band of Luiseño Indians & UC Riverside, and Mark Hoddle, UC Riverside

Palomar mountain 2022 drone survey showing ~ 30% tree mortality

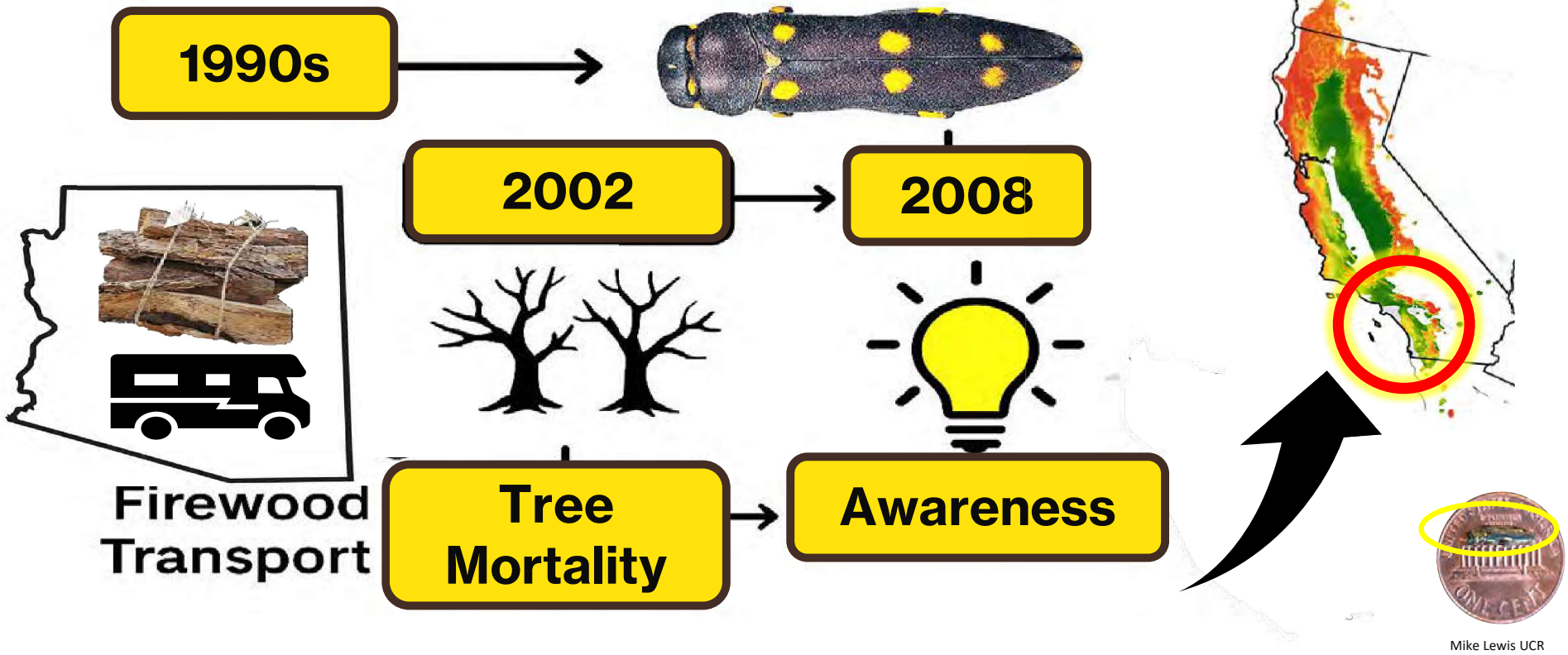
Ongoing oak mortality, likely caused by goldspotted oak borer, located near Palomar Mountain, San Diego County.

2022 Forest Service Ariel Detection Survey 11/11/2025

North San Diego County Highway 76 - Altered fire regime.

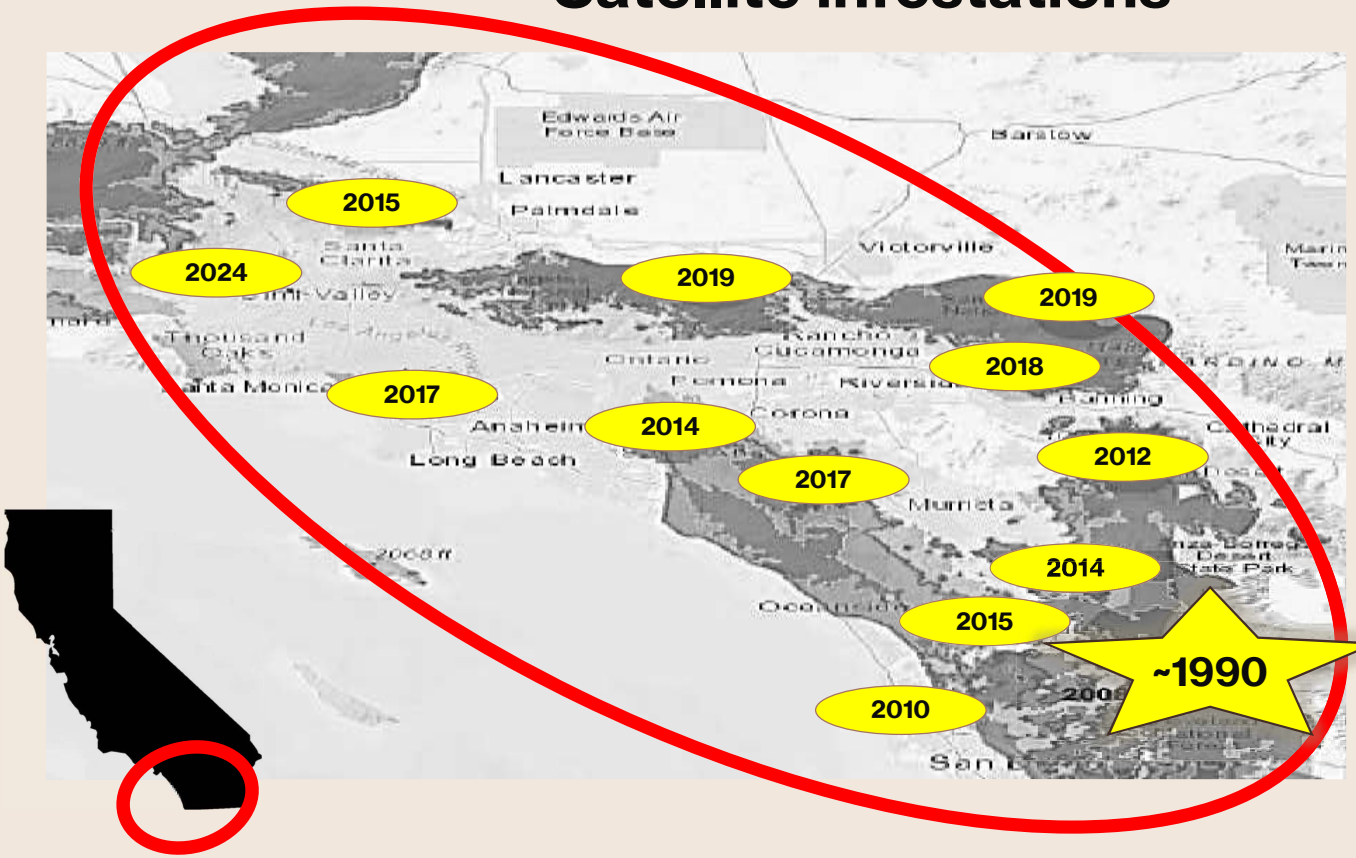
Drone showing at least 50 dead oaks associated with goldspotted oak borer infestation

Spread of the invasive *Agrilus auroguttatus* – Goldspotted Oak Borer in California



1. Coleman TW, Seybold SJ (2008a) New pest in California: the goldspotted oak borer, Agrilus coxalis Waterhouse.
2. Coleman, Seybold SJ (2008b) Previously unrecorded damage to oak, Quercus spp., in Southern California by the goldspotted oak
3. Venette,; Coleman, Seybold,. 2015. Assessing the risks posed by goldspotted oak borer to California and beyond.
4. Coleman & Seybold. 2010. Verification of a useful character for separating the sexes of the goldspotted oak borer, Agrilus coxalis auroguttatus (Coleoptera: Buprestidae)

Satellite infestations



Over past 25+ years an estimated ~200,000 oak trees died [1]

6 counties: Ventura, Riverside, San Bernardino, Orange, Los Angeles, San Diego

Satellite infestations: noncontiguous with natural dispersal as noted by years

1. Tamm, C. Dominguez, R. Campos, J. Heraty, and M.S. Hoddle "First occurrence of *Balcha indica* (Mani & Kaul, 1973) (Hymenoptera: Eupelmidae), parasitizing *Agrilus auroguttatus* Schaeffer, 1905 (Coleoptera: Buprestidae), in California," *The Pan-Pacific Entomologist* 101(3), 217-228, (6 October 2025). 3. Map on left: https://ucanr.edu/sites/gsobinfo/Diagnosis_and_Management/GSOB_Management_StoryMap/

Mechanisms of injury:

Annual Attack: Larvae feed on the tree's vascular system each year.

Cumulative Damage: This repeated feeding steadily weakens the tree.

phloem feeding decreases food transport

Cambium feeding stops new growth

Xylem feeding inhibits water & nutrient uptake

System Failure: Eventually, the vascular system sustains too much damage.

Photos by J. Tamm La Jolla Band Indians & UC Riverside

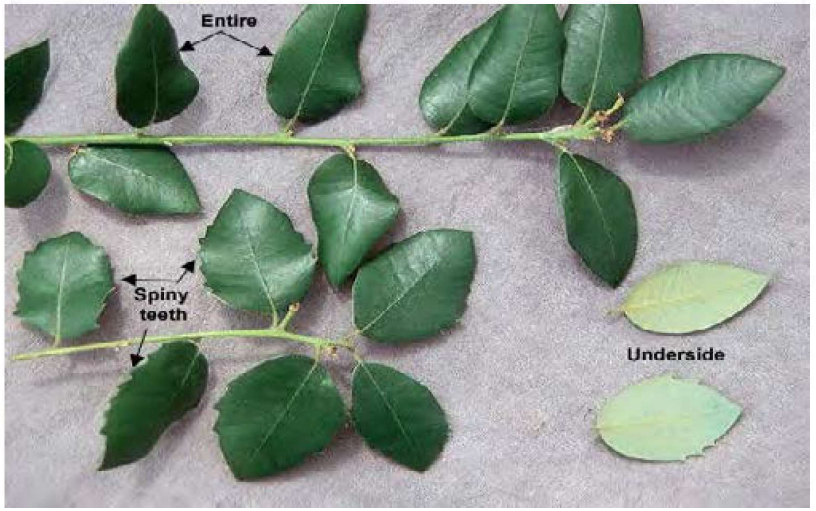
Current California GSOB *Quercus* genus host trees:

Red Oak Section

Coast Live oak
Q. agrifolia

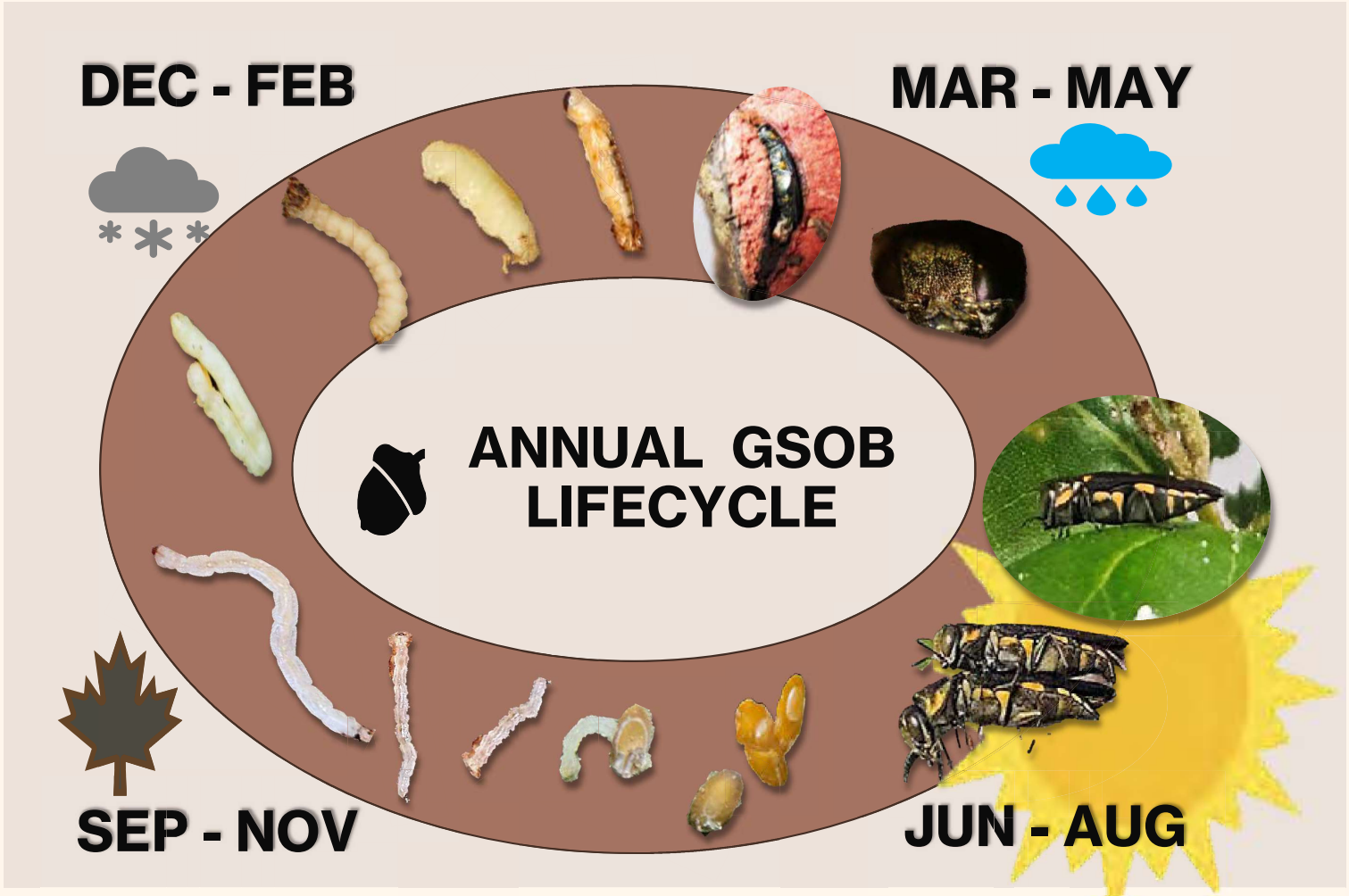
California black oak:
Q. kelloggii

Golden Cup Oak section



Canyon Live oak
Q. chrysolepis

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



Egg (Summer): Laid in bark crevices; hatches in ~10 days.

Larva (Summer/Fall): Bores into the tree to feed and grow. Overwinters as a mature larva in a pupal cell within the **outer bark**.

Pupa (Spring): Transforms into an adult while still inside the tree.

Adult (Summer/Fall): Chews a **D-shaped exit hole** to emerge. Feeds on leaves, mates, and lays eggs to restart the cycle.

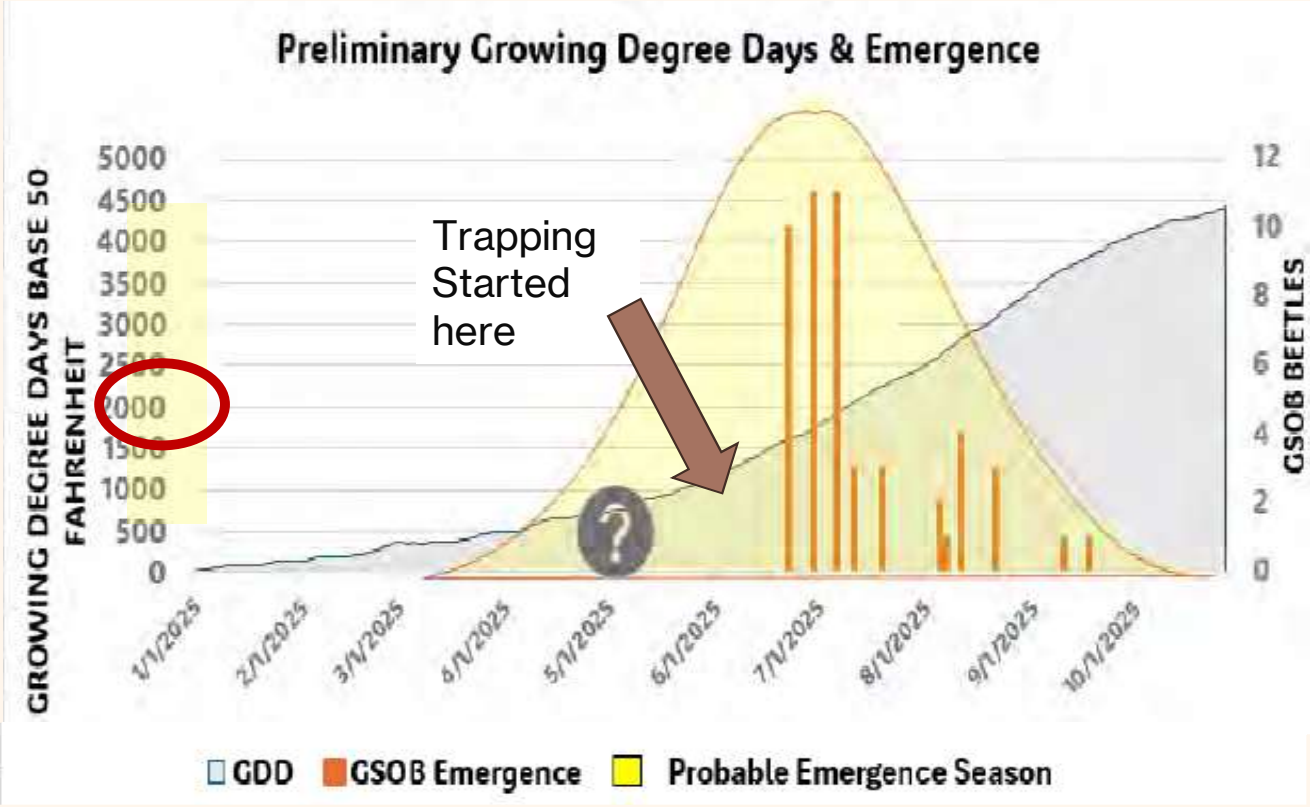
Growing Degree Days model for GSOB

Understanding emergence patterns

Emergence Season: March- November (400-4000 GDD)

Peak Emergence: Late June-early July (1500-2000 GDD)

Firewood Warning: Emergence from infested firewood begins *sooner* than standing trees.



1. https://www.aphis.usda.gov/sites/default/files/eab-survey-guidelines.pdf

Detection trapping:

Low catch rates:
UV light, branch beating

Moderate catch rates:
Flight intercept sticky prism traps

Preliminary high catch rate:
Sticky tree band trap for spongy moth

Signs of GSOB infestation

"D-shaped" exit holes

GSOB adults chewing out of tree

Adult in pupal chamber

Pupa/larva in pupal chamber

Pupal chamber under bark

Larvae in phloem

Larve in cambium

Frass filled galleries

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 . Photos by J. Tamm La Jolla Band Indians/UC Riverside 3. Mike Lewis UC Riverside

Symptoms of GSOB tree injury

Bark bleeding & staining [1,2]

Cracked bark [1,2]

Shallow woodpecker foraging [1,2]

Thinning crowns [1]

Sudden crown death

Tree mortality [1,3]

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 . Photos by J. Tamm La Jolla Band Indians/UC Riverside 3. Mike Lewis UC Riverside

Surveying: “D-shaped” Exit holes

Hishinuma et al. 2011

No exit holes	Low 1-9 exit holes on main stem	Moderate 10-25 exit holes	Severe >25 exit holes	Amplifier tree 25 - 100 exit holes and tree is still alive

Lessons learned: **Trees with more than 10 exit holes are unlikely to be saved by insecticide treatments**

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 . Photos by J. Tamm La Jolla Band Indians/UC Riverside 3. Mike Lewis UC Riverside

Surveying – Bark Symptoms

0	1	2	4	5
No bleeding	1 - 5 stains on lower stem	6 - 10 stains on lower stem	> 10 stains on lower stem	Bark is cracked to sapwood
Healthy	Minor	Moderate	Severe	Dead

Lessons learned: **Insecticide treatments are unlikely to save trees showing excessive bark bleeding, horizontal bark cracking, or exposed sapwood.**

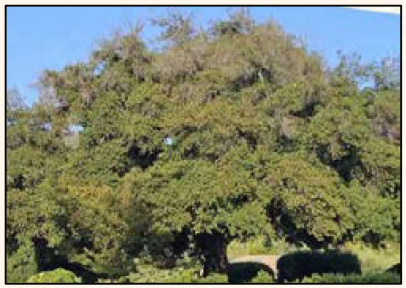
1. Hishinuma, S., T. W. Coleman, M.L. Flint, and S. J. Seybold. 2011. Goldspotted oak borer: Field identification guide, University of California Agriculture and Natural Resources, Statewide Integrated Pest Management Program, 6 pp., January 13, 2011 . Photos by J. Tamm La Jolla Band Indians/UC Riverside 3. Mike Lewis UC Riverside

Surveying Tree Crowns for Health Assessment

1

Full Crown
0% leaf loss

Healthy



2

Minor Dieback
10-25%

Minor

3

Moderate thinning 25 - 50% dieback

Moderate

4

Severe dieback > 50%

Severe

5

Dead tree

Dead

Lessons learned: **Insecticide likely to save trees with healthy crowns or minimal damage. Crown rating is useful but can be a "false negative" GSOB indicator.**

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 . Photos by J. Tamm La Jolla Band Indians/UC Riverside 3. Mike Lewis UC Riverside

Limit Firewood Movement

The Threat in a Single Log

1. **1 Piece of Firewood** (1 ft × 1 ft) can release **28 adults** in one month.

- **14 Females** (at a 50% sex ratio) can lay up to 8,500 eggs.

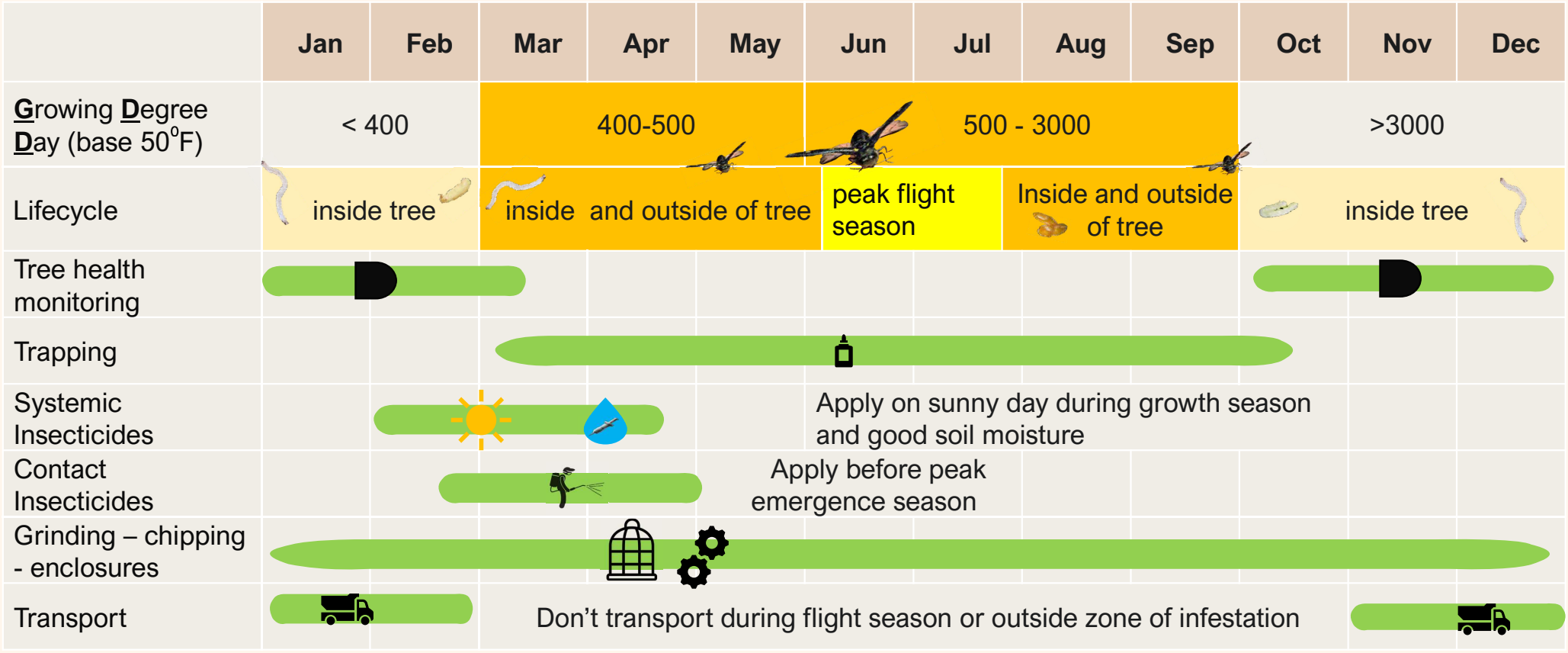
2. **1% Survival Rate** = **~32 – 84** new adults from a single log.

DONTMOVE FIREWOOD.org

FIREWOODSCOUT.ORG

GSOB Integrated Pest Management

The goldspotted oak borer (GSOB) is an invasive wood-boring beetle that severely damages oak trees. Use these integrated pest management techniques to help reduce damage.



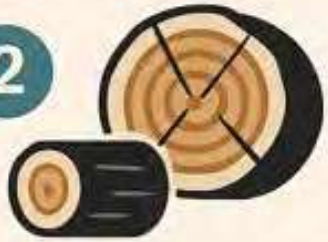
Based on [8] *Coleman, T.W.; Jones, M.I.; Smith, S.L.; Venette, R.C.; Flint, M.L.; Seybold, S.J. 2015. Goldspotted oak borer, *Agrilus auroguttatus*. USDA Forest Service, Forest Insect & Disease Leaflet No. 183, 16 p
& observations by J. Tamm 2025 & Presentation by Bea Nobua Behrman 2025

Safe Disposal: Chipping, Debarking & Grinding

1. **grind** infested wood to particles **<3 inches** using a 3-inch "minus" screen.

Grinding large rounds

2. Remove bark and at **least 1 inch** of sapwood to eliminate GSOB

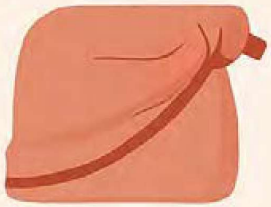


Chipping small limbs

DO NOT TRANSPORT OUTSIDE OF ZONE OF INFESTATION

[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

Containing Infested Wood
Tarping & Enclosing

1. 

Cover with **plastic tarps** (6-mil, UV-resistant)

2. 

Use **fully screened woodsheds** with fine mesh

3.

GSOB beetles tend to gather in corners and are attracted to light. If plastic or vinyl is not layered or firmly against infested wood, beetles will cluster in corners and remain inside rather than attempting to escape

Infestation Risk & Safe Firewood Handling

Wood can be infested for up to 2 years after harvest

1 Secure wood on-site

Allow firewood to season for two years in afully contained storage area (e.g., a screened woodshed or a sealed tarp.)

2 years

2 Leave logs whole in in isolation

Attach clear notice in infestation details and the date cut.

⚠ WARNING ⚠
INFESTED WOOD – DO NT MOVE
Moving this wood spreads invasive pests and kills more trees. Visit

PEST IDENTIFIED: Goldspotted Oak Borer
DATE IDENTIFIED / CUT: ___/___/___
SCHEDULED REMOVAL DATE: ___/___/___

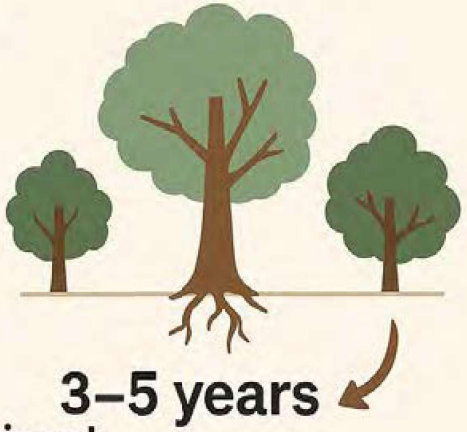
For Information. Please Contact:
LANDOWNER:
Name: _____
Phone: (___) ___ -
HARVESTER Permit
Name: _____
Phone: (___)____ -

2 years

Mortality Centers

Rapid Final Decline

- Once symptoms **appear** (e.g., canopy thinning), dominant trees typically die within **3–5 years.**



- Surrounding **suppressed** and **codominant** trees also die because they tolerate less damage.

Thinning is Effective to Remove:

Amplifier/Brood Trees – trees that accelerate infestation

A historical forestry practice used to reduce damage

La Jolla Indian Campground 2017

2025 after 50% canopy loss and removal of dead and dying trees

*Asaro, Christopher, Frank H. Koch, and Kevin M. Potter. 2023. "Denser Forests across the USA Experience More Damage from Insects and Pathogens." *Scientific Reports* 13 (1): 3666.

Highway 76 Community collaboration

Critical Assets:

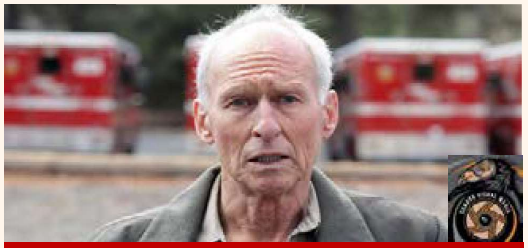
- Evacuation, Residences, Transportation
- High-voltage power lines
- Emergency communication towers

The GSOB Threat:

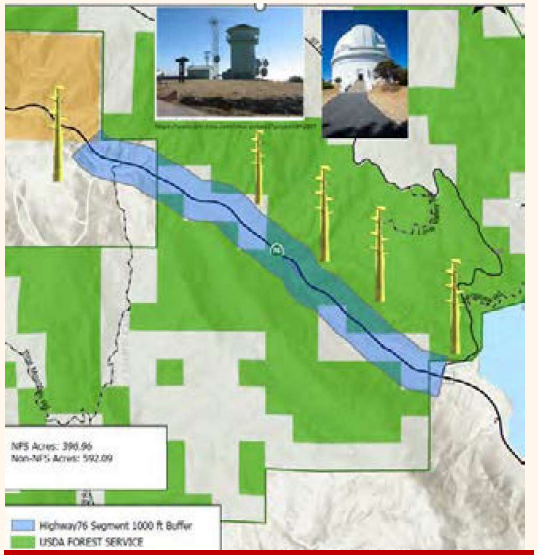
- Dead, dying trees dramatically increase wildfire risk.
- Endangers infrastructure, the public, and first responders.
- Threatens to block emergency routes during a crisis.

Our Response:

A multi-agency partnership was formed on November 12, 2024, to address this threat.



Concerned property owner



Focus area and jurisdictional boundary map

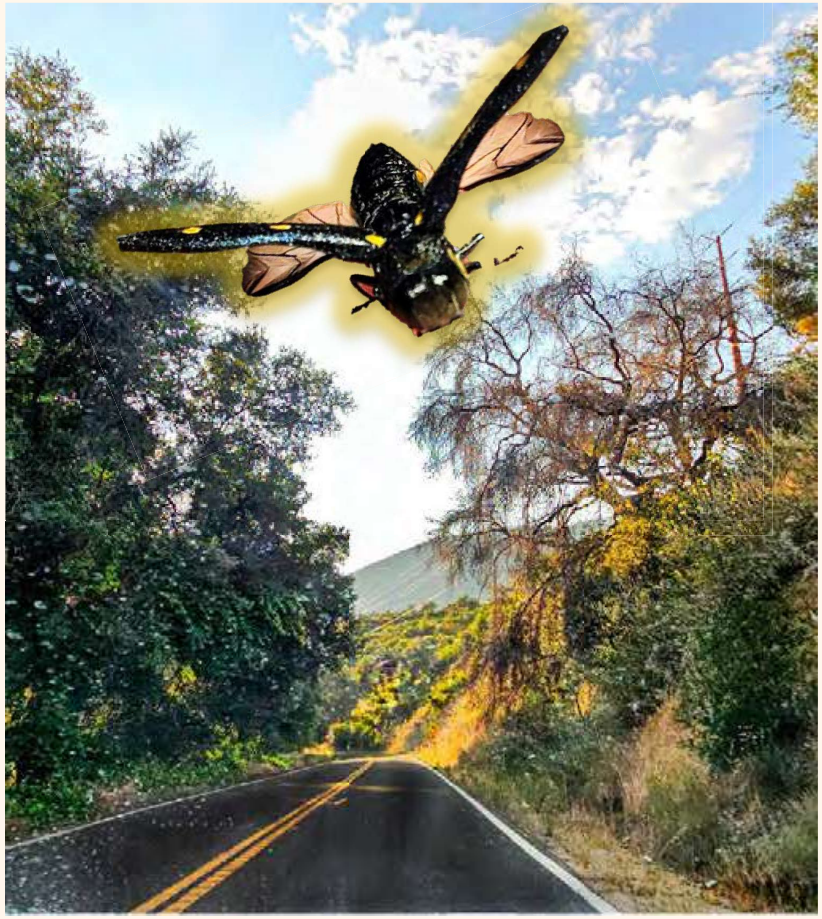
Collaboration meeting at Fox Fire Center -

Interagency and Inter-Tribal Fire Department group photo on La Jolla Burn Unit

Addressing GSOB Impacts on Highway 76 Corridor

Accomplishments & Progress:

- **USDA Forest Service:** Secured funding to remove 1,400 trees.
- **CALTRANS:** Secured $1 million to remove 87 trees.
- **La Jolla Band of Indians:** Awaiting decision on $2 million grant application.
- **Current Action:** Caltrans has marked trees for removal along the reservation to Lake Henshaw.

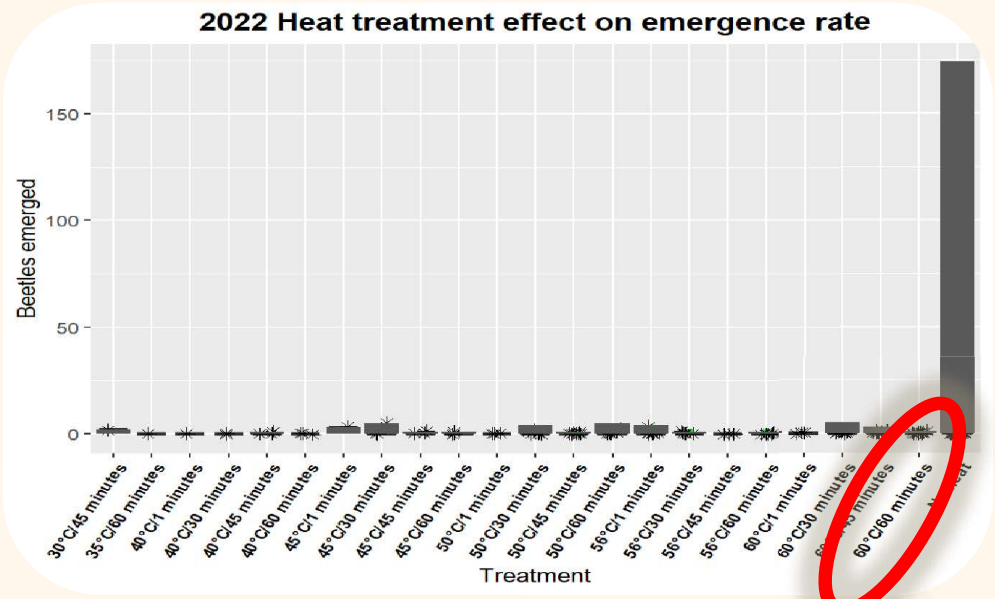


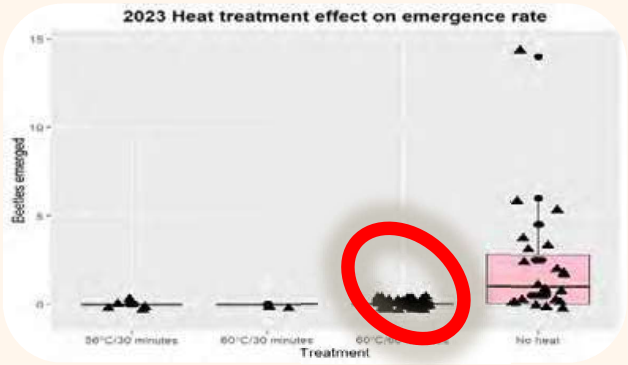
Heat Treatment

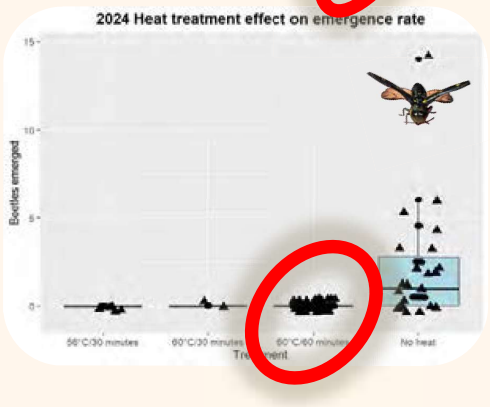
Heat Treatment: A Promising Solution
Preliminary research shows that heat treatment was **100% effective** at killing GSOB in infested wood over a four-year study period.

The Protocol:
Heat core of wood to **60°C (140°F)**.
Maintain for **60 minutes**.
Protocol T314-a verified to sanitize emerald ash borer infested wood)

Disclaimer: *This GSOB-specific research is currently pending peer review.*







Pile Burning for GSOB Control

Option 1: Complete Consumption

Burning infested wood until it is 100% consumed is a guaranteed way to kill all insects.

Research pile burn in progress

Option 2: Heavy Charring (Preliminary research)

Less intensive burn can be highly effective.

Charring for > 7 minutes reduces GSOB emergence by 96% compared to untreated wood

Charred logs

GSOB specimens from unburned logs

Asaro, Christopher, Frank H. Koch, and Kevin M. Potter. 2023. "Denser Forests across the USA Experience More Damage from Insects and Pathogens." *Scientific Reports* 13 (1): 3666.

Cultural burning & prescribed fire

Research Status: Inconclusive and ongoing as a land management tool

Benefits: Thinning & prescribed fire improve forest health; cultural or Rx fire helps mitigate damages

Indigenous Knowledge: Fire, ash, and smoke reduce insect damage and activity before and during harvest [1,2,5]

Top: Cultural burn in progress photo by Condor Visual Media

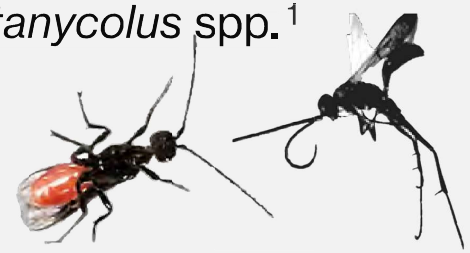
Top: Test fire photo by Condor Visual Media

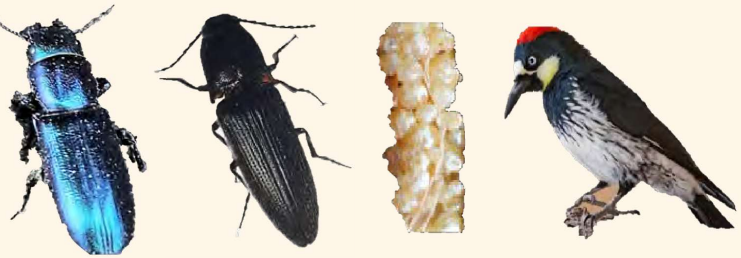
1. Anderson, K. (2005). Tending the wild Native American knowledge and the management of California's natural resources. 2. Hakbijl, T. (2002) The Traditional, Historical and Prehistoric Use of 2. Ashes as an Insecticide, with an Experimental Study on the Insecticidal Efficacy of Washed Ash, Environmental Archaeology 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.
7. Bean, Lowell John and Florence C. Shipek (1978). *"Luiseno", Handbook of North American Indians, Volume 8.* Smithsonian Institution, Washington, D.C..

Known natural enemies:

Eupelmidae: *Balcha indica* [3]

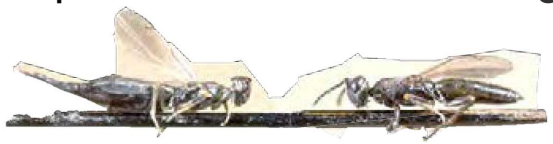
Braconidae: *atanycolus* spp.[1]





Left to right: bark gnawing beetle [2], click beetle [2] parasitic mite, *Pyemotes tritici*, woodpecker.
Below: Left: Trichogrammatid sp. [2], Right: Cheyletid mites [6]

Eupelmidae: *Calosota elongata* [5]



Eupelmidae: Unidentified Calosotinae species [6]

Chalcididae: *Phasgonophora sulcata*

1. Coleman, T., Jones, M., Smith, S., Venette, R., Flint, M., Seybold, S., 2017, Forest Insect Disease Leaflet 183, *Published by USDA Forest Service, Pacific Northwest Region (R6), Portland, Oregon* FS/R6/RO/FIDL#183-15/001 (Rev. 08/2017 2. Lopez, V., Hoddle, M.,2013, Mortality factors affecting Agrilus auroguttatus Schaeffer (Coleoptera: Buprestidae) eggs in the native and invaded ranges, Biological Management, Volume 67, Issue 2, p. 143-148, ISSN 1049-9644,2. 3. Tamm et al. 2025, 4. Tamm observation 5. Haavik et al 2012. 6. Tamm unpublished

TAKE HOME MESSAGES

Threat: GSOB is a deadly invasive pest causing widespread oak mortality. Early detection is paramount.

Triage Rule: Proactive treatments can protect healthy or lightly-infested trees but are **ineffective** on trees already showing moderate to severe damage.

The Best Defense: The most effective and sustainable strategies are **Exclusion** (don't move firewood!) and promoting long-term **Forest Health**.

Path Forward: Using an **Integrated Pest Management (IPM)** approach is essential to make responsible decisions and protect our environment.

Future: Continued **research** is essential to develop new tools and refine our strategies to protect California's oaks for generations to come.

Thank you for your time & attention

GSOB has been unfortunate, but it has forced us to work together and start taking care of the woodlands again!

Questions & Discussion:

Many thanks to the La Jolla Band of Indians, Hoddle and Heraty Lab, UCANR, Forest Service, CALFIRE, and all our partners!

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