

**Living with Bears: Mapping Black Bear (*Ursus americanus*) Movement and Habitat Connectivity in California's Northern Bay Area to Proactively Reduce Conflict**



Photo: Getty

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With additional support from the North Bay Bear Collaborative's partner agencies and individuals.

## Objectives

Bears have long been part of California's ecological and cultural history, but their connection to the region has diminished due to grizzly extermination, urban growth, and an intolerance of large predators<sup>1</sup>. Now, as black bears are expanding into California's Northern Bay Area<sup>2,3</sup> (i.e. the North Bay), a region once filled with grizzlies, there is an opportunity to rekindle a positive relationship between humans and bears. This proposal will aid the North Bay Bear Collaborative in answering questions about seasonal bear movement and habitat connectivity to proactively inform strategies for coexistence in Sonoma, Marin, and Napa counties by:

1. Mapping black bear movement and habitat suitability range in the North Bay across seasons.
2. Identifying highway crossing corridor(s) that would best serve East-West black bear movement across highway 101.
3. Developing recommendations to land stewards to adapt to an increasing black bear population.
4. Creating educational outreach materials about black bears for North Bay residents.

## Implications

Bears play a vital role in maintaining healthy ecosystems. By consuming fruits and berries, they act as seed dispersers, spreading seeds across large areas and promoting plant growth and biodiversity<sup>4</sup>. Their foraging and feeding behaviors contribute to nutrient cycling, enriching the soil with their waste and redistributing nutrients within the ecosystem<sup>5</sup>. These effects are amplified when salmon become part of the bear's diet, as they transport rich, marine derived nutrients in the form of salmon carcasses from rivers where they are spawning into the wider landscape<sup>6</sup>. This is a timely discussion when looking at the North Bay, given the recent return of spawning salmon following recovery efforts<sup>7</sup>. In addition to their contributions to the nutrient cycle, bear foraging disturbances on the forest floor can aid plant regeneration and create habitats for other species<sup>8</sup> and by scavenging carrion, they help reduce waste and limit the spread of disease<sup>9</sup>. Consequently, an increasing population of black bears in the North Bay reflects an opportunity to restore important ecosystem functions to the region.

However, more adequate infrastructure and educational resources are needed to encourage positive human interactions with black bears<sup>10</sup>. In many areas of the United States, conflict with bears is a regular and problematic occurrence, with incidents spanning property damage, livestock and pet predation, and public safety concerns. Black bears are known to be highly responsive to the opportunities and risks that humans create for them, such as open trash cans and food left in cars. This can lead to incidences of habituation, where bears become too comfortable around people, behavior which can then be passed down to cubs. Habituated bears show reduced avoidance of human-related infrastructure, such as houses and roads, in comparison to non-habituated bears<sup>11</sup>. This highlights a decrease in their natural wariness of human presence, which can lead to increased risks of conflicts, accidents and, in some cases, euthanasia<sup>12</sup>. One example of this is seen in the Lake Tahoe region, where a tourist hotspot overlaps with one of the most densely populated areas of black bears in the United States<sup>13</sup>. With very few currently habituated bears in the North Bay, this project seeks to support a proactive, rather than reactive, approach toward managing human-bear interactions.

The North Bay Bear Collaborative (NBBC) is a group of agencies, nonprofits, landowners, and individuals working together to lower incidences of conflict through research, community outreach, and infrastructure improvements. This project would aid in these efforts through a combination of mapping to visualize bear movements and suitable habitat, the creation and provision of education and outreach materials, and a proposed wildlife crossing. By providing mapping of bear movement and a habitat suitability analysis, NBBC will be able to predict when bears are likely to use certain areas most. This can

be used to inform management decisions for livestock, crops, vineyards, prescribed burns, etc. Project outcomes would aid NBBC in spreading awareness to foster a positive human-bear culture, ultimately supporting black bear populations to sustainably flourish in the North Bay.

### Equity

Bears and Indigenous people lived alongside each other for millenia in North America, with some tribes holding true that bears taught their people what to eat<sup>14</sup>. Both humans and bears were important actors in shaping the ecology and food sources of their environment. Consequently, with the systematic and rapid extermination of native people and large predators, the natural balance was disrupted. Supporting the peaceful re-expansion of bears into the North Bay, and relearning how all people can co-exist with them, is a small but important step toward restoring historical cultural connection to the region.

Partner organizations of NBBC work closely with the California Indian Museum and Cultural Center and regional tribal councils before employing management decisions. This project would seek similar guidance throughout to ensure the analysis and educational materials are aligned with regionally relevant Indigenous perspectives and goals.

### Available Data

Data in the below table will primarily allow us to meet objectives 1 and 2 of the project. These results will then be used to inform objectives 3 and 4.

<b>Data</b>	<b>Owner</b>	<b>Description</b>
DNA Data	NBBC	500-600 scat samples with individual bear DNA, lat/long, gender, and material breakdown (nuts, fruit, fur etc.).
Camera Trap Data	NBBC	Thousands of processed camera trap data points from 2013 - present, showing presence of bears including location, date, and time which will allow us to map bear movement and potential corridors.
Community Bear Sighting Reports	NBBC	~200 standardized reports of bear sightings, including date, time, location, and habitat, valuable for identifying human-bear interaction hot spots.
<a href="#">Sonoma County LiDAR Data</a>	Sonoma County Ag & Open Space	Publicly available LiDAR data to be used for habitat modelling including vegetation and plant-based food sources.
<a href="#">Marin County LiDAR Data</a>	Marin County	Publicly available LiDAR data to be used for habitat modelling including vegetation and plant-based food sources.
<a href="#">Napa County LiDAR Data</a>	Napa County	Publicly available LiDAR data to be used for habitat modelling including vegetation and plant-based food sources.
Bear Collar Data*	CDFW	Temporal and spatial data on collared bear movements throughout the North Bay. Currently only four bears are collared but more are due to be done this year.

\*Pending approval for use on the project. While this additional data layer is a nice-to-have, it would not be necessary for the main objectives of the project.

As well as the existing data, the project will look into conducting surveys to gauge community sentiment on increasing black bear populations. Surveys may be tailored to different audiences such as vineyards,

residents, etc., to gain a deeper understanding of the issues faced by different community groups. This is a time-dependent additional piece of work which is not crucial to the project's success but would be used to further inform NBBC's communication efforts. Survey outcomes would be used to help inform objectives 3 and 4 of the project.

### **Possible Approach**

This project will link bear presence data from scat samples and camera traps with environmental data from county-specific LIDAR data and other publically available topographic and environmental data to model habitat suitability using Maxent. Models will be created to reflect seasonal variation in resource availability. Circuitscape will be applied to these models to identify critical connectivity needs and points where wildlife crossings over major highways might be most beneficial. This will provide an in-depth visualization of the current and forecasted seasonal black bear movement through the region. The scat samples will also allow the group to analyze seasonal food preferences to provide further insight into bear activity patterns across seasons. Depending on availability of forthcoming data and the group's capacity to engage with more advanced analysis, bear collar data may also be used to further inform understanding of bear movement in the study region. While this would be nice to include, it is not necessary for the project's success.

The movement mapping will aid in creating management recommendations to land stewards in order to support coexistence. Collaboration with stakeholders – potentially including the Kashia Band of Pomo Indians, the California Department of Fish and Wildlife, the California Indian Museum and Cultural Center, regional land trusts, state, national and county parks, and local land managers – will ensure findings are accurate and actionable, with recommendations refined with their input.

Educational material will be made to help spread awareness to the general public about black bears in the North Bay based on findings from the movement mapping and food preference analysis. Survey data, if available, will be used to further strengthen and focus materials towards various groups. Regional leaders and natural history educators will be consulted to leverage local knowledge and efforts.

### **Deliverables**

In addition to a final written report, executive summary, and oral presentation, the team will produce:

- GIS Story-Map: To visualize black bear movements across the region, assessing seasonal variability and habitat preferences.
- Management Recommendation Guide: A set of guidelines for land stewards, to be used to inform management decisions and planning.
- Wildlife Crossing Proposal/Recommendation: To aid black bear and other wildlife connectivity from East to West across the 101 and reduce traffic collisions.
- Educational Outreach Material: Online or printed infographics providing information on black bears, and recommendations on how to coexist alongside them.

### **Internships**

Multiple unpaid internships in Summer 2025 will be available through NBBC and/or one of the partner organizations—such as Pepperwood Preserve, Sonoma Ecology Center, and Napa Land Trust—depending on interests of the student(s) and fit with the organization. Supervisors will be available to support the student(s). There are no funds to be able to compensate the intern(s) at this time.

## Citations

1. Mychajliw, A., Adams, A., Brown, K., Campbell, B., Hardesty-Moore, M., Welch, Z., Page, H., Southon, J., Cooper, S., & Alagona, P., 2024. Coupled social and ecological change drove the historical extinction of the California grizzly bear (*Ursus arctos californicus*). *Proceedings of the Royal Society B*, 291. <https://doi.org/10.1098/rspb.2023.0921>
2. Todd, K. (2024) *Black Bears Move Into The North Bay*. Available at: <https://baynature.org/article/black-bears-by-the-bay/> (Accessed: 12/20/2024)
3. California Department of Fish and Wildlife. (2024). *Draft black bear conservation plan for California*. Sacramento, CA: California Department of Fish and Wildlife. Retrieved from <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=222075&inline>
4. Enders, M., & Wall, S., 2012. Black bears *Ursus americanus* are effective seed dispersers, with a little help from their friends. *Oikos*, 121, pp. 589-596. <https://doi.org/10.1111/J.1600-0706.2011.19710.X>
5. Holtgrieve, G., Schindler, D., & Jewett, P., 2009. Large predators and biogeochemical hotspots: brown bear (*Ursus arctos*) predation on salmon alters nitrogen cycling in riparian soils. *Ecological Research*, 24, pp. 1125-1135. <https://doi.org/10.1007/s11284-009-0591-8>
6. Levi, T., Darimont, C., MacDuffee, M., Mangel, M., Paquet, P., & Wilmers, C., 2012. Using grizzly bears to assess harvest-ecosystem tradeoffs in salmon fisheries. *PLOS Biology*, 10(4).
7. Coryell, R. (2024) *Reviving the rivers: Sonoma County's mission for salmon revival*. Available at: <https://www.sonomacountygazette.com/sonoma-county-news/reviving-the-rivers-sonoma-countys-mission-for-salmon-survival/> (Accessed: 01/09/2025).
8. Michelfelder, V., 2004. A study of forest understories in two parts : community structure of forage plants consumed by coastal black bears and effects of partial cutting on understory
9. Allen, M., Elbroch, M., Wilmers, C., Wittmer, H., & Fenton, B., 2014. Trophic Facilitation or Limitation? Comparative Effects of Pumas and Black Bears on the Scavenger Community. *PLoS ONE*, 9. <https://doi.org/10.1371/journal.pone.0102257>
10. Rigby, A. (2023) *How do we foster a "bear culture" again?*. Available at: <https://www.egret.org/how-do-we-foster-a-bear-culture-again/> (Accessed: 12/20/2024)
11. Powell, R., Mansfield, S., & Rogers, L., 2022. Comparison of behaviors of black bears with and without habituation to humans and supplemental research feeding. *Journal of Mammalogy*, 103, pp. 1350 - 1363. <https://doi.org/10.1093/jmammal/gyac081>
12. Hopkins, J., Koch, P., Schwartz, C., Ferguson, J., Greenleaf, S., & Kalinowski, S., 2012. Stable isotopes to detect food-conditioned bears and to evaluate human-bear management. *Journal of Wildlife Management*, 76, pp. 703-713. <https://doi.org/10.1002/JWVG.318>

13. Williams, P. (2024) *Lake Tahoe's Bear Boom*. Available at:  
<https://www.newyorker.com/magazine/2024/12/02/lake-tahoes-bear-boom> (Accessed:  
12/20/2024)
14. Watershed Sentinel. (n.d.). *Bears teach us sharing with all our relations*. Retrieved January 8,  
2025, from <https://watershedsentinel.ca/articles/bears-teach-us-sharing-with-all-our-relations/>

**Budget and justification**

The expenses for this project will not exceed the \$1,000 allotment from the Bren School.

## Client letter of support



January 6th, 2025

Bren School of Environmental Science and Management  
2400 Bren Hall  
UC Santa Barbara, California 93106

Dear Bren Group Project Committee,

We are writing to express our support for a Bren School group project titled *Living with Bears: Mapping Black Bear (*Ursus americanus*) Movement and Habitat Connectivity in California's Northern Bay Area to Proactively Reduce Conflict*.

The North Bay Bear Collaborative (NBBC) is a working group of non-profit conservation groups, state and federal agencies, tribes, agricultural landowners and individuals committed to being proactive liaisons between humans and black bears. Our current collaborators are:

- Audubon Canyon Ranch
- CA Dept. of Fish and Wildlife
- CA Indian Museum and Cultural Center
- CA State Parks
- Kashia Pomo Tribe
- Jackson Family Vineyards
- Land Trust of Napa County
- One Tam/Golden Gate National Recreation Area
- Pepperwood
- Private Landowners
- Redwood Coast Land Conservancy
- Sonoma County Ag and Open Space
- Sonoma County Regional Parks
- Sonoma County Wildlife Rescue Center
- Sonoma Land Trust
- UC Davis

Our mission is to rebuild a bear culture in San Francisco's North Bay region through research, education, and land stewardship. This includes ongoing community science, public outreach, and land management towards resilient and diverse habitats. We strive to help bears stay wild, in our open spaces, and out of our neighborhoods.

We are excited about this proposed project, as several components fit well with our mission and goals. NBBC is in year 5 of an ongoing black bear DNA project. This DNA project identifies individual bears and their relatedness. In addition, when collecting scat, we compile data on habitat use and diet. This information helps us to understand bear dispersal and habitat connectivity hot spots. Adding to our

growing DNA data, we also use wildlife camera arrays and community observations to better inform us on bear movements and forage preferences.

Though black bears are not an endangered species, they can pose significant bear-human challenges. While grizzly bears have always been part of this North Bay ecosystem, black bears colonizing and dispersing into the North Bay is novel and recent. In the past 10 years we have seen a significant increase in black bear population. Given the high density of humans and an increasing bear population, NBBC is dedicated to being proactive and mitigating negative bear-human interactions before North Bay black bears become habituated. We strongly feel this proposed project can help elucidate when and where the bears are in the North Bay. This will allow us to prioritize management locations and strategies.

Many of our partnering organizations and agencies have a long history of working in the field of habitat connectivity. With regular occurrences of wildfire and an increased human population, wildlife corridors have become a focal point for NBBC. As we see wildlife, including black bears, retreat out of burning areas, only to return days to weeks later when the fire has passed, connectivity is crucial for bear and wildlife survival.

Beyond conserving and protecting important connected habitat, we are also curious about how black bears are crossing Hwy 101. Through our DNA study we have identified an east west movement from eastern Sonoma County to western Marin County. To ensure safe passage and continued genetic flow, we want to answer the question of how the black bears are traversing Hwy 101.

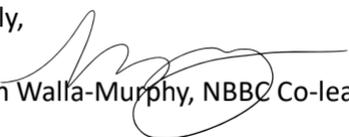
Because our organization is a true collaborative of multiple stakeholders, we are uniquely poised to aid this project by offering diversified skill sets, voices, and experiences in wildlife and conservation fields. While any student who participates in this project will formally be an intern of NBBC, they will also be working under the tutelage and mentorship of one out of several collaborative members, such as Pepperwood Preserve, Sonoma Ecology Center, or Napa Land Trust.

NBBC also has multiple years of data to share; camera data since 2013, five years of DNA data, as well as hundreds of data points accumulated from community members sharing bear sightings in the North Bay. This added to LIDAR vegetation data available through Napa, Marin, and Sonoma counties allows for a robust and applicable project.

The collaborative nature of our organization also means that no one person works full time for NBBC. Given this we rarely have the capacity to chase many of our questions. This project's outcomes will not only aid in our management goals, but a story map and education materials will help NBBC reach a larger audience. The more people with greater ecological literacy, the more likely peaceful co-existence between bears and humans. Having a team of dedicated Bren students would be a deeply appreciated gift.

NBBC is excited and willing to help facilitate successful outcomes and ensure a meaningful learning experience for the Bren students.

Sincerely,

  
Meghan Walla-Murphy, NBBC Co-lead.